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MOSQUITO STUDIES (Diptera, Culicidae)

VII. The Culicidae of New Zealand.

By John N. Belkin.

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VII. THE CULICIDAE OF NEW ZEALAND[1]

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INTRODUCTION

In a previous study (Belkin 1962:15-18) I alluded to the extraordinary nature and taxonomic importance of the mosquito fauna of New Zealand and outlying islands. All but 1 of the indigenous species of this fauna are endemic and the majority of these appear to have retained more significant primitive features than any other living representatives of their respective phylads. The desirability of a thorough knowledge of this relict mosquito fauna from the standpoint of composition, distribution and detailed knowledge of the individual species cannot be overemphasized for studies on the morphology and phylogeny of the Culicidae and their biogeography. Unfortunately even at the conclusion of the above-mentioned study only very fragmentary knowledge of this fauna was available and very little material for more detailed studies was to be found in museums outside of New Zealand.

The present study is based primarily on material collected by myself and Donald A. Schroeder in 1963-1964. Additional specimens have been kindly provided by L. J. Dumbleton, D. A. Forsyth and E. R. Nye. I have also examined the collections at the Auckland Museum (AUCK), Canterbury Museum (CANT) and at the Department of Scientific and Industrial Research, Nelson (NELS). I thank all the above individuals and institutions and also Roy Elliott, E. S. Gourlay, D. D. McCarthy, J. S. Pillai and particularly C. Arthur and Mary K. Schroeder for innumerable favors and assistance during my brief visit in New Zealand. I am also indebted to Patricia Donnelly for a preliminary study of the larval and pupal chaetotaxy of Nothodixa campbelli and Paradixa fuscinervis, carried on as a research problem in the Department of Zoology, University of California, Los Angeles. Thomas J. Zavortink, O. George W. Berlin and Sandra J. Heinemann prepared and checked most of the material for this study. The preliminary drawings were made by Rainer Beck and Anne Acevedo and the final drawings were all made by Sharon Burmeister. Without their arduous toil this study could not have been completed and I am most grateful to all of them for expert assistance.

Nearly 20,000 specimens (1376 ♂, 1844 ♀, 13662 larvae, 2706 pupae), representing all the 24 recognized species and including more than 1000 individual rearings (580 larval, 364 pupal, 100 incomplete) of 19 species, were examined during this study. Some material of both sexes and all stages was studied for all species except as follows: (1) no females or immature stages of Neodixa minuta, (2) no males or immature stages of Nothodixa philpotti, (3) no immature stages of Nothodixa otagensis, (4) no females of Nothodixa septentrionalis, (5) no larvae of Coquillettidia tenuipalpis, (6) no larvae of Coquillettidia iracunda, and (7) no immature stages of Corethrella novaezealandiae.

The primary objectives of this publication are to describe and figure in some detail previously unrecognized species or stages and to provide more complete descriptions and illustrations of those New Zealand species which are the types of generic group taxa. Special emphasis is given to the morphology of the poorly known Dixinae. I have also taken this opportunity to present a review of previously published data on New Zealand Culicidae to provide a basis for more detailed future studies which I hope will be undertaken by New Zealand investigators.

The methods of study and presentation are essentially similar to those I used in "The Mosquitoes of the South Pacific" (Belkin 1962). A few modifications in the terminology are introduced and explained in the general discussions of the Dixinae and Culicinae. In the illustrations only some pertinent details are shown and many features have been eliminated. This applies particularly to illustrations of adults where the scale pattern is usually not shown and to the figures of leg segments which are designed merely to indicate the proportions.

Because of paucity of published information of the bionomics and distribution of New Zealand Culicidae I have included an Appendix in which the data on our collections are summarized and have provided detailed distribution lists and maps for each species. The collection data are not repeated in the lists but can be obtained from Appendix A by reference to the collection number which is identified by the code NZ. The numbers on the detailed distribution maps also refer to the NZ collection numbers in Appendix A.

In the distribution lists, the arrangements of localities is from north to south and west to east, grouped under the land districts except for the islands of Hauraki Gulf which are listed individually after the North Auckland land district. Included in these lists are all other records of material I have examined as well as some published records of specimens I have not seen but consider reliable. All these miscellaneous records are indicated on the detailed distribution maps but without collection numbers.

MORPHOLOGY

Basic to phylogenetic studies is the determination of primitive (plesiomorph) and derived (apomorph) states of various attributes. In this respect, the culicids of New Zealand hold a unique position because in nearly every indigenous phylad many primitive characters have been retained and because both the Dixinae and Culicinae are well represented. As one of the main criteria available for determining the primitive states in a group without a good paleontological record is comparison with the conditions exhibited in coordinate taxa, I have made a special effort to study the morphology of the Dixinae in order to determine the probable primitive states of various attributes in the Culicinae.

Due to the lack of material from Southeast Australia, Tasmania, Chile and Patagonia, thorough detailed comparative morphological studies could not be carried out during this investigation. However, the preliminary studies on the Dixinae of New Zealand (see) suggest that this group holds the key to understanding the morphological composition of the male genitalia of the Culicinae as has been shown to be the case by Martini (1923) for the morphology and chaetotaxy of the caudal abdominal segments of the larvae. I have proposed a new morphological terminology for the components of the phallosome of the Dixinae which is discussed under that subfamily and is illustrated in fig. 7. One of these components, the opisthophallus, is recognized here for the first time in the Culicinae (see). Detailed comparative studies of the immature stages of the Dixinae of New Zealand have led to some corrections and a reinterpretation of the chaetotaxy with the result that the pattern is so similar to that of the Culicinae that there is little doubt that it is truly homologous in the 2 groups.

In the discussion of the Culicinae (see), I have indicated what I believe to be primitive states for some characters of this group exhibited by New Zealand species. Almost all of these are similar to those of New Zealand Dixinae but some are unique developments of the Culicinae.

SYSTEMATICS AND BIOGEOGRAPHY

Although our current knowledge of the culicid fauna of New Zealand is still fragmentary some speculations regarding its affinity, origin and evolution seem warranted. I have summarized my views on these matters in the discussions of the Dixinae and Culicinae, which are both well represented in New Zealand. The details of the probable affinities are dealt with under the individual species and groups. Here only a general summary and broad generalizations are presented.

Of the 24 species definitely known to occur in New Zealand, Culex (C.) quinquefasciatus is undoubtedly a recent introduction and Aedes (F.) notoscriptus was probably also introduced subsequent to the colonization of New Zealand. Of the remaining 22 species, only Aedes (H.) australis is known outside of the New Zealand area. Three monotypic genera (Neodixa, Opifex and Maorigoeldia) and 3 monotypic subgenera (Austromansonia, Nothoskusea and Notocorethrella) are recognized for New Zealand species. Only a few of the other endemic species appear to have close relatives anywhere in the world.

The culicid fauna of New Zealand is a well balanced one, with a representation of all 3 subfamilies and all the major phyletic lines within each of these except the Chaoborinae. The poor representation of the latter may be due at least in part to the predaceous nature of the larvae. Nearly all the major phyletic lines present in New Zealand appear to be ancient ones and within these, the individual elements seem to have retained a greater number of significant primitive features than any other living representatives of their respective phylads. The apparent absence of certain groups generally considered to be "primitive," especially the tribes Anophelini, Toxorhynchitini and Uranotaeniini, is very striking. I submit that these phylads failed to invade New Zealand either because of their absence in the source areas or their representation there by species with poor dispersal powers or limited adaptability to new environments at the time that dispersal routes were available. Neither the Toxorhynchitini nor the Uranotaeniini are now known from Southeast Australia-Tasmania. The Anophelini are represented by a number of apparently ancient relict species in these areas and it is possible that they did reach New Zealand but have not been able to survive.

A striking feature of the fauna is the presence of only 2 indigenous container breeders, Maorigoeldia argyropus and Culex (C.) asteliae, all the remaining indigenous forms being ground water breeders. It appears that the specialized container habitat was first utilized in the Culicinae by the Sabethini which show the most striking derived features in the larval stage and are all container breeders. The utilization of this habitat appears to be incipient in the ancient stocks of Culicini as shown by the facultative use of large treeholes by many species of Culex (Culex) and the derivation of Culex (C.) asteliae from the pervigilans stock in New Zealand. The absence of indigenous container breeders in the Aedini of New Zealand suggests that this habit had not been acquired by the more ancient stocks of the tribe at the time of its entry of New Zealand.

The majority of New Zealand species appear to have moderate powers of dispersal and great ability to survive in small populations as shown by their presence on small islands in Hauraki Gulf, such as Little Barrier Island.

There is relatively little geographical differentiation in the culicid fauna of New Zealand; most species occur throughout the main islands and adjacent islets. The significant exceptions are: (1) Aedes (N.) chathamicus, restricted to Chatham Island, (2) Aedes (H.) australis and Aedes (O.) subalbirostris, restricted to the southern part of South Island, and (3) several relict species in the Dixinae (see). In the widespread species, there is little indication of differentiation in the different populations except to a limited degree in Culex (C.) pervigilans.

In general, each phyletic line is represented by a single species in New Zealand. The only exceptions are in the Dixinae (see) and the Culex pervigilans complex. Speciation within New Zealand in both these instances appears to have occurred through isolation, accompanied by ecological (Culex, Nothodixa) or genitalic (Paradixa) barriers.

The affinities of the culicid fauna of New Zealand are largely with the fauna of Southeast Australia-Tasmania. Only the genera Nothodixa and Neodixa show definite relationship with the fauna of both South Chile-Patagonia and Southeast Australia-Tasmania. The affinities in all but 1 or 2 cases are not very close and in nearly all these instances the New Zealand species have retained more primitive features than their relatives and therefore it appears that they could not have derived directly from the latter. In several instances, apparent relatives of New Zealand stocks, and in some cases Australian as well, are found in the Northern Hemisphere, notably in Paradixa, Culex (C.) pervigilans, Culiseta (Climacura), Coquillettidia (C.) and Aedes (Ochlerotatus).

At least 3 waves of dispersal probably took place in the population of New Zealand by culicid stocks. The earliest involved only the Nothodixa-Neodixa line and occurred probably at the same time as the classical southern hemisphere dispersals of plants. Evidently the other culicid stocks were not present in the source areas at this time. The second dispersal involved the bulk of the culicid fauna of New Zealand after the connection (direct or indirect) with South America was broken. There is a suggestion that 2 separate waves may have been involved in this dispersal in the separation of Opifex and Aedes (N.) chathamicus, the presence of different lineages in Paradixa, and the slight differentiation between the elements on North Island and South Island. The final dispersal is a much more recent one, involving apparently only Aedes (H.) australis.

In summary, the indigenous culicid fauna of New Zealand has all the earmarks of an ancient continental fauna, probably largely Mesozoic in origin. The land connections for the dispersals need not but may have been continuous; relatively short barriers may have been efficient filters at certain times and may account for the absence of a few ancient stocks. On the other hand, the barriers probably were not very great at other times as the Sabethini and the Dixinae, which are apparently incapable of crossing extensive ocean barriers, were able to reach New Zealand. Subsequent to the isolation of the New Zealand area and coincident with later geological changes a limited geographical differentiation of the original Mesozoic culicid fauna has taken place without any additions (except perhaps for Aedes (H.) australis) from external sources until the introduction through human agency of Culex (C.) quinquefasciatus and probably Aedes (F.) notoscriptus. In the course of time there has probably been considerable attrition in the culicid fauna, only those species surviving that have been able to adapt to the great environmental changes since the Mesozoic. This, I believe is shown by the great plasticity of the majority of present day forms in their ability to utilize a wide range of habitats and in their considerable tolerance of temperature and salinity.

As I have indicated earlier (Belkin 1962:58), the most likely places for the ultimate origin of the stocks which populated New Zealand and the other South Pacific islands are islands in the tropical unstable Old World intercontinental area. Even the so-called antarctic element represented by *Nothodixa*-*Neodixa* could have had its ultimate origin in this area and dispersed only to the south because of the availability of dispersal routes only in this direction. This intercontinental origin of new types would explain also the presence of related but distinct stocks in the northern and southern hemispheres, as in the case of *Paradixa*, *Culex (C.) pervigilans*, *Culiseta (Climacura)*, *Coquillettidia (C.)* and *Aedes (Ochlerotatus)*, by the dispersal of a new type from the intercontinental area to both hemispheres because of availability of dispersal routes and subsequent independent evolution in widely separated areas.

KEYS TO SUBFAMILIES

Adults

1. Mouthparts long, labium forming a long rigid proboscis . . . Culicinae
Mouthparts short, labium not elongated into a rigid proboscis 2

2(1). Wing veins without or with only a few inconspicuous short hairs; vein Sc ending on wing margin near level of furcation of R . . . . . Dixinae
Wing veins with numerous long hairs or hairlike scales; vein Sc ending on wing margin distinctly distad of furcation of R (24. *Corethrella novaezealandiae*) . . . . Chaoborinae

Male Genitalia

1. A distinct paramere developed between the basal piece and aedeagus . . . . Culicinae
Aedeagal sclerites articulating directly with basal piece 2

2(1). Phallosome very simple, consisting of a poorly developed basal piece and projecting aedeagal sclerites, which are not bent back into an aedeagal pouch (24. *Corethrella novaezealandiae*). . . . Chaoborinae
Phallosome complex, basal piece strongly developed, prosophallus or opisthophallus or both strongly developed, aedeagal pouch always present, penis filament sometimes developed . . . . Dixinae

Pupae

1. Abdominal tergites with incomplete submedian transverse ridges; segment IX well developed, distinct sternally. . . . . Dixinae
Abdominal tergites without submedian transverse ridges; segment IX poorly developed, indistinct sternally. 2

2(1). Paddles fused at base, not articulated *or* trumpet without pinna or tracheoid but with large ovoid reticulate meatus and small apical process . . . . Chaoborinae
Paddles always separate and articulated at base *and* trumpet usually with pinna; if pinna indistinct then trumpet without large ovoid reticulate meatus and small apical process . . . . .Culicinae

Larvae

1. Venter of abdominal segments I or I and II with short unsegmented paired

lobes (prolegs) ending in recurved spines; thoracic segments same width as abdominal and rather distinctly separated . . . . . Dixinae

Venter of abdominal segments I and II without such lobes; thoracic segments consolidated into a single mass wider than abdominal segments and not segmented 2

2(1). Mouthbrushes completely absent or represented at most by about 5 long bristlelike spicules . . . . Chaoborinae

Mouthbrushes always well developed, usually very numerous, rarely reduced to about 10 heavy long flattened spines. . . . . . . .Culicinae

SUBFAMILY DIXINAE

The Dixa Midges

Dixa midges are readily recognized from true mosquitoes by the characters given in the key to the subfamilies. A general account of the subfamily with emphasis on New Zealand forms is given by Belkin (1962:93-96) to which the following additions and corrections based on a more detailed examination during the present study should be added.

MALE GENITALIA. A thorough comparative study of the male genitalia of the Dixinae has not been made yet but it appears from even a cursory examination of the New Zealand species and a few extralimital forms that the Dixinae hold the key to understanding the morphological composition of the male genitalia of the Culicinae. There is a bewildering array of specializations of the basic sclerotizations and apodemes associated with the genital opening, intromittent organ, sidepiece and proctiger developed from a very generalized primitive type which is perhaps best represented in the New Zealand species of Nothodixa and Paradixa.

For the present I am continuing the terminology I have used in the past (Belkin 1962) and I am introducing only a few new terms which are discussed here and illustrated in fig. 7. In this discussion the usual descriptive taxonomic terminology of orientation will be used and the morphological relationships will be mentioned only when they are obvious or necessary.

The basic support and articulation points for all sclerites associated with the phallosome complex and proctiger are provided directly or indirectly by a highly complex apodeme, the basal piece, which appears to be primarily a development from the mesal dorsal angle of the sidepiece, although primitively it may have been an apodeme from the entire mesal margin of the sidepiece or from both its dorsal and ventral mesal angles. In the Dixinae the basal piece is much more extensive and complex than in most Culicinae. I distinguish 2 parts in the basal piece, the distal division (ventral) which projects inside the sidepiece itself and the proximal division (dorsal) which projects inside segment IX. The 2 divisions are continuous and it is not always possible to separate them distinctly; certain portions of either division may acquire articular points.

Although very complex, the phallosome of New Zealand Paradixa seems to be the most primitive in the entire family. I recognize 3 basic components: (1) a ventral prosophallus or claspette, (2) the phallus proper and (3) a dorsal opisthophallus or dorsal claspette.

The prosophallus consists of a transverse lobe between the mesal ventral edges of the 2 sidepieces. It is supported by a simple transverse sclerite (prosophallic sclerite) which is joined on each side to a ventral arm of the distal division of the basal piece. The prosophallus is probably the homolog of the claspette of the Culicinae. In the Dixinae it is variously modified into median or submedian processes along its distal margin and may be separated into basal and distal portions which, however, are continuous. Ventrad of the prosophallus is a small depression (sternal pocket) between the posterior margin of sternite IX and the base of the 2 sidepieces which meet at the bottom of the depression.

The *phallus* is the median lobe associated with the gonopore. In New Zealand *Paradixa* its support is provided by a sclerite (aedeagal sclerite) on each side connected to the central part of the proximal division of the basal piece. In other Dixinae (e.g. N. Z. *Nothodixa*) it becomes articulated with a long process from the latter. This process through further differentiation and articulation, I believe, becomes the *paramere* of the Culicinae. The aedeagal sclerites proper form the aedeagus and may become completely fused on the dorsal surface but are usually at least partially separated on the ventral surface of the phallus.

The gonopore in New Zealand *Paradixa* is always ventrad (morphologically cephalad) of the aedeagal sclerites. It is usually in a depressed membrane between the aedeagal sclerites and the prosophallic sclerite but in *harrisi* it is located within the apex of the proximal division of the prosophallic sclerite. It is possible that the latter condition is the primitive one but this cannot be resolved without extensive comparative study of related families. I have noted in some North American Dixinae similar sclerotizations around the gonopore apparently derived from a proximal division of the prosophallus.

The *opisthophallus* consists of a transverse lobe between the mesal dorsal edges of the 2 sidepieces. It is dorsad (morphologically caudad) of the phallus and lies between the latter and the venter of the proctiger. I believe that the opisthophallus belongs to the 9th abdominal segment but have made no attempt to determine its exact morphological composition. The opisthophallus is supported on each side by a sclerite (*opisthophallalic* or *lateral sclerite*) articulated with the outer part of the proximal division of the basal piece. In New Zealand *Paradixa* the opisthophallus is very complex and its lateral sclerite articulates dorsally with the ventrolateral sclerite of the proctiger. In New Zealand *Nothodixa* the opisthophallus is a relatively simple large lobe whose lateral sclerites are poorly sclerotized and do not articulate with the membranous proctiger distally. The opisthophallus has not been studied or even recognized in the majority of Culicinae. However, it is evident that it is strongly developed in some forms, notably in *Maorigoeldia* and in the subgenus *Verrallina* of *Aedes*.

The phallic complex in New Zealand species of *Nothodixa* is of considerable interest since it appears to represent a very primitive condition which may explain the derivation of the penis sheath and penis filament in other species of *Nothodixa* and various extralimital paradixines. In the New Zealand species the parameres are very long slender capitate apodemes which project caudomesad to articulate with a moderately sclerotized cordate median plate located at the dorsal end of a median longitudinal depression bounded at the ventral end by the prosophallus and supported laterally by a pair of submedian longitudinal lightly sclerotized processes from the prosophallus. This depression is probably homologous with the *aedeagal pouch* of Spielman (1964, 1966) and the phallotheca of Snodgrass (1935). The cordate median plate I consider to be composed of fused aedeagal sclerites. At the apex (anterior end) of the cordate plate is a small scoop-shaped, rounded, heavily-sclerotized median process which is continued ventrally into the aedeagal pouch as a short slender curved free median penis filament. This filament appears to have an open groove on one surface and it is probably the actual intromittent organ which probably enters the distal end of the spermathecal duct of the female in copulation. I think it is very likely that the penis filament is also developed from the aedeagal sclerites. It is possible, however, that the apical process of the cordate plate is derived from the proximal division of the prosophallus, that it surrounds the gonopore as in P. harrisi, and that it is joined to the aedeagal sclerites secondarily. I have not been able to determine exactly the relationship of the gonopore to the penis filament but it is probably located in the vicinity of the apical process of the cordate plate which bears a striking resemblance to a structure found at the ventral base of the aedeagus near the gonopore in many Culicinae.

Nothodixa chilensis Alexander, 1913 shows a further step in the evolution of the penis filament and the development of the penis sheath. In this species the parameres are very short, transverse and heavy and are broadly joined to the heavily-sclerotized posterolateral walls (aedeagal sclerites) of the aedeagal pouch which is very deep and narrow. The base (anterior end) of the aedeagal pouch is developed into a very narrow invagination (the penis sheath) projecting into the body. The penis filament arises at the fused bases of the 2 aedeagal sclerites and projects into the invagination cephalad along its dorsal wall then curves back distad along its ventral wall and finally dorsad between the narrowed lips of the aedeagal cup to emerge free a considerable distance above its base. The proximal part of the penis filament appears to be solid and part of the posterior wall of the aedeagal pouch. Therefore it is possible that the true penis filament is the free distal, grooved part only.

Two South American species of Nothodixa (ensifera and nitida, both Edwards, 1930) are noted for the development of an external penis sheath containing the penis filament; in ensifera this sheath is longer than the entire abdomen. I have not studied the morphology of the phallosome of these species but it seems probable that the penis sheath of these species is nothing more than an external evagination of the distal part of the aedeagal pouch which instead of projecting into the body, has been evaginated in the area dorsad of the prosophallus to accommodate the excessively long penis filament.

Elongate penis filaments located in internal sheaths in general similar to but often much longer than in Nothodixa chilensis are known in a number of paradixines, e.g. californica Johannsen, 1923 and Dixina solomonis Belkin, 1962. In californica the dorsal and ventral walls of the penis sheath are strongly sclerotized, these sclerotizations being continuous with those of the base of the aedeagal sclerites and of the submedian processes of the prosophallus. The free penis filament arises from the ventral wall deep within the penis sheath and curves along the ventral wall. Peters and Cook (1966) and others have used incorrectly the term "ejaculatory duct" for the penis filament of the Dixinae.

It is of interest that the intromittent organ (aedeagus, penis filament) in the Culicidae is withdrawn at rest into a pouch (aedeagal pouch, penis sheath) and that the gonopore lies near its base on the ventral surface (morphologically anterior) and not at its apparent apex. I suggested (Belkin 1962:178) that in Culex the aedeagus proper is deeply retracted at rest and Spielman (1964, 1966) has demonstrated this and shown the relationship of the gonopore to the aedeagus in Aedes aegypti and Culex quinquefasciatus. It appears that in most Culicinae the aedeagus is not a tubular structure but is troughlike on its ventral surface which is largely membranous and that within this membrane lies the gonopore. I have shown above that in New Zealand Nothodixa the penis filament is withdrawn at rest deep into the aedeagal pouch. In New Zealand Paradixa the aedeagal sclerites are also withdrawn at rest into a shallow depression between the sidepieces and the prosophallus and are folded back against a median process of the distal division of the prosophallus so that the gonopore lies hidden in a small pocket ventrad of them.

The proctiger of the Dixinae also shows much differentiation which may be of taxonomic significance. In many forms (e.g. New Zealand Nothodixa, many other Dixini and apparently some Paradixini) it has no distinct sclerotizations and the cercal lobe is large and bears many setae. In New Zealand Paradixa strong basolateral sclerotizations with spinelike processes are developed and are articulated at base with the lateral sclerite of the opisthophallus. In this group the cercal setae are few in number and are borne on a distinct process which may be short or very long.

The ninth segment is strongly developed in all Dixinae and exhibits much differentiation in various groups. Its tergite is greatly enlarged in species or groups in which the opisthophallus and the proctiger are strongly developed, as in New Zealand Paradixa. In the latter, the lateral tergite of the opisthophallus appears as a posterior lateral piece of abdominal tergite IX.

The sidepiece and clasper are the only parts of the male genitalia of the Dixinae which have attracted wide attention in the past. Because of very strong specific differentiation in the size, shape and lobes of these structures, the sidepiece and clasper have been the primary means of recognizing and diagnosing species and most workers have not gone beyond this point in studying the genitalia. None of these specializations appear to have any significant value in recognizing natural groups or evolutionary lines.

FEMALE GENITALIA. The female genitalia of the Dixinae of New Zealand have not been studied in detail and little attention has been paid to them elsewhere until the work of Peters and Cook (1966). These authors figured them for many North American species but did not attempt to use them in the classification of the group. There appear to be many different developments in the bursa copulatrix and it seems probable that these are correlated with developments of the phallosome complex of the male genitalia. Therefore it is likely that a detailed study of the female genitalia will prove to be of value in developing a natural classification of the Dixinae.

GENERAL ADULT MORPHOLOGY. There is a remarkable uniformity in the general external morphology of the adults and very few good taxonomic characters have been found. The length of the antenna and the shape of the flagellar segments show the most striking differentiation and form the basis for the separation of the subfamily into 2 tribes, Dixini and Paradixini. Differences in wing venation are present but their usefulness for classification is limited because of convergence or parallelism in unrelated lines. Color patterns of the body and wings are useful only at the specific level. Secondary sexual characters of the legs of the male and of the hindtibia may be of some value in classification but have not been studied extensively.

CHAETOTAXY OF IMMATURE STAGES. As a result of a comparative study of the larvae and pupae of species from New Zealand some corrections have been made in my former interpretation of the chaetotaxy of the Dixinae (Belkin 1962:94) as indicated in the figures and explained below.

In the pupa, cephalothoracic hair 1-C may be present and it may be possible that 2-C is also present but this could not be determined definitely; hair 4-C may be absent. The ventral abdominal hairs have been renumbered and hair 12 was found on segments III-VI.

In the larva, the dorsal head hairs have been renumbered. The hair formerly interpreted as 0-C belongs to the labrum (palatum) and is eliminated in the nomenclature while a small hair in the posterior part of the head, not recognized before, is now interpreted as hair 8-C. Hairs formerly interpreted as 1, 2, 3, 4, 5, 6, 8-C now become 0, 1, 3, 2, 4, 5, 6-C respectively. On the thorax, hairs 2, 3-P, M are interchanged. On abdominal segment II, hair 11 becomes 10 and a small hair on the proleg is hair 11; ventral hairs 10-12 on abdominal segments III-VII are all renumbered as indicated in the figures.

With this reinterpretation, the chaetotaxy of the Dixinae appears even more similar to that of the Culicinae, the chief differences being the absence of hair 8 on all abdominal segments of the larva and pupa, the caudal displacement of hair 8-C on the head capsule of the larva, the absence of hair 12 on abdominal segments I, II of the larva, and the absence of some hairs on the thorax of the larva. Even the positions of many hairs follow the same pattern as in the Culicinae.

Almost all hairs in the Dixinae are unbranched, only some of the heavier larger hairs are barbed and a few of the shorter hairs may have a few branches in some forms. However, there is considerable differentiation in the length and thickness of hairs and this character appears to be of considerable importance in differentiating the 2 tribes and some genera.

Differences in chaetotaxy pattern, including loss of some hairs, have been noted in the present study. Some of these differences seem to be at a generic level at least and may prove to be of value in determining evolutionary lines in the subfamily.

PUPA. The general morphology of the pupa of New Zealand dixa midges is very uniform but the following characters are apparently of at least generic value: the length of the antennal sheath, shape of the pinna of the trumpet, and the chaetotaxy pattern. Specific differences will probably be found primarily in the spiculation or tuberculation of the integument, in pigmentation, in the shape of the trumpet and in the length of the paddle. Because of differences in morphology from the Culicinae the measurements of the length of the abdomen and of the paddle are determined in the following manner. The abdomen is measured from the anterior border of segment I to the posterior border of segment VIII; the paddle from the base of segment IX to the apex of the paddle.

LARVA. The general morphology of the larva is quite uniform not only in the New Zealand species but in all the extralimital forms I have examined. However, group differences at the tribal and generic level have been noted in the following: (1) development of "crowns" or rosettes of branched spinules on the dorsum of abdominal segments, (2) number of abdominal prolegs, (3) arrangement of hooks on prolegs, (4) number of ambulacral combs, (5) spiculation of the antenna, (6) development of tentorium, (7) development of collar on head capsule, (8) development of the labium and labial process of the head capsule, (9) numerous features of the spiracular apparatus, (10) marginal teeth of the pecten, (11) sclerotizations of the anal segment, (12) postanal spicules, and (13) chaetotaxy, including length of hairs. Closely related species appear to be extremely similar and show differences primarily in pigmentation of the head capsule, pigmentation and spiculation of the antenna, and spiculation of the thorax and abdomen.

A special descriptive terminology is used here for the larva of the Dixinae primarily for features of the spiracular apparatus and anal segment. The head length is measured from the anterior border of the labrum (palatum) to a line connecting the posterolateral angles of the head capsule. The length of the posterolateral lobe is measured in lateral or dorsal aspect from the dorsal end of the basal unsclerotized line separating it from the pecten plate to the apex of the lobe exclusive of the marginal spicules. The length of the anal segment is measured on the dorsal midline from the base of the saddle to the apex of the distal caudal process. The cylindrical process is the complete sclerotized ring at the apex of the saddle separated by an unsclerotized line from the distal caudal process.

SYSTEMATICS AND BIOGEOGRAPHY. After this more detailed study of the dixa midges of New Zealand, particularly of the male genitalia and immature stages, I am convinced that the similarities between them and true mosquitoes are due to common ancestry and not to convergence. It is inconceivable that the absolute correspondence of all the elements of the chaetotaxy of the spiracular lobe (or apparatus) and of the 8th (and 9th) abdominal segments of the larvae of Dixinae and Culicinae, first shown by Martini (1923) and later confirmed by Belkin (1951), is due to anything other than common ancestry of the 2 groups. Therefore, I am retaining the dixa midges as the subfamily Dixinae of the Culicidae. As before (Belkin 1962:88), I consider that the Dixinae, Culicinae and Chaoborinae arose contemporaneously from a common ancestor and that the Dixinae are not in any way ancestral to either of the other 2 subfamilies although they appear to have retained more primitive features than the latter.

Judging by the morphology of the known existing types, their breeding sites and their distribution, it seems probable that the Dixinae split into 2 major evolutionary lines very early, probably earlier than the first radiation occurred in the Culicinae or Chaoborinae, and that neither line has been successful in occupying a breeding environment different from the original one (ground waters). This general conservatism is also shown in the preservation of many primitive general characters in the Dixinae and the great similarity in basic characters in the larva, pupa and adult within the entire subfamily.

Speciation in the Dixinae appears to have been determined largely by unique specializations in the phallosome of the male genitalia and probably, at least in some groups, by correlated specializations in the female genitalia, producing a mechanical isolating barrier between species. Speciation has been accompanied by very few and minor changes in the general external characters of the adults, primarily in the antenna, palpus, wing veins and pigmentation, legs, and pigmentation of the body. In the immature stages the changes have also been relatively few and inconspicuous in the general morphology, except in the trumpet of the pupa and in the spiracular apparatus, anal segment, prolegs and body spiculation of the larva. The only striking differences noted in the larvae so far are the development of the abdominal rosettes in the Dixini and the presence of only 1 pair of prolegs in Meringodixa. However, it is evident from the present study that obscure but significant differences in the chaetotaxy of the immature stages distinguish some evolutionary lines in both the larvae and pupae and that differences in some of the other characters of these stages mentioned above are also of taxonomic significance.

It would appear therefore that a natural classification of the subfamily should be based primarily on fundamental characters of the male and female genitalia and of the immature stages. These characters must be evaluated very carefully since parallel developments are evident in the 2 major evolutionary lines in the subfamily, e.g. development of a penis filament in the Dixini and Paradixini, elongate flagellar segments in adults of *Meringodixa* and the Paradixini, similar type of larval antennal spiculation in Dixini and Paradixini, and so on.

To date taxonomic studies of Dixinae have consisted largely of species recognition and diagnosis on the basis of external adult characters and superficial details of specialization of the sidepiece and clasper of the male. Because the latter show such excellent diagnostic features that are readily visible, very little attention has been paid to the complex structures of the phallosome and proctiger of the male which require dissection and careful interpretation. The larvae and pupae are undescribed for most species and the few that are known are not described in sufficient detail to evaluate significant features.

The primary division of the subfamily into the tribes Dixini and Paradixini, based on characters first recognized by Tonnoir (1924b), appears to be a natural one and as far as I can determine all the described genera fit into one or the other readily. The generic classification, on the other hand, is in a confused state at the present largely because the type species of most genera have not been described in sufficient detail for the significant taxonomic characters and stages. The majority of species have been placed in either *Dixa* or *Paradixa* (or *Dixella* following Lane 1949:257; 1951:336) depending on the length of the antenna and the shape of the flagellar segments of the adults and sometimes presence or absence of the dorsal abdominal rosettes in the larvae. It is evident that both genera are polyphyletic assemblages and probably contain species which could be placed better into some of the other described genera or should be segregated into new genera or subgenera.

The Dixini include the following genera: *Dixa* Meigen, 1818; *Neodixa* Tonnoir, 1925 (= *Dixella* Tonnoir 1924b); *Nothodixa* Edwards, 1930; and *Meringodixa* Nowell, 1951; the latter was originally placed in a separate monotypic tribe because of some annectent characters between the Dixini and Paradixini but most of its features warrant its inclusion in the Dixini for the present. The Paradixini include 4 genera also: *Dixella* Dyar and Shannon, 1924; *Dixapuella* Dyar and Shannon, 1924; *Paradixa* Tonnoir, 1924b; and *Dixina* Enderlein, 1936. The genus *Eriopterites* Meunier, 1916 is a homonym of *Erioptera* Meigen, 1803 according to art. 56(b) of the International Code of Zoological Nomenclature since Meunier proposed this name for a fossil species (*tertiaria*) which he stated to be without a doubt a species of *Erioptera*. This form is not a tipulid but a dixa midge whose generic placement is uncertain. Therefore no replacement name for *Eriopterites* is needed at this time.

Details of the affinities and systematics of New Zealand Dixinae are discussed under each genus and species below. Only the general features of this fauna are reviewed here. The fauna is harmonious, extensive and entirely endemic at the species group level. It consists of apparently the most primitive living representatives in each of the 2 major phyletic lines. The Dixini are represented by the genus *Nothodixa* (4 sp.) which is known elsewhere only in Tasmania, New South Wales, Chile and Patagonia, and the derived aberrant monotypic *Neodixa*, still known only by the male holotype. *Nothodixa* probably dispersed to New Zealand very early at a time when a suitable dispersal route to South America was also present in the Southern Hemisphere. The New Zealand species of *Nothodixa* have typical disjunct relict populations; there is no detectable differentiation in the phallosome of the 3 species known in the male sex or any feature of the pupa in the 2 species known in this stage, and the larvae of the 2 known species are extremely similar except for modifications in the prolegs. The Paradixini are represented by the genus *Paradixa* (4 sp.) which is definitely absent from Chile and Patagonia and whose extralimital distribution is apparently confined to Tasmania and New South Wales although it is possible that different phyletic lines assignable to this genus are present in the Northern Hemisphere. *Paradixa* probably dispersed to New Zealand contemporaneously with most Culicinae after the earlier dispersal of *Nothodixa* and at a time when suitable dispersal routes to South America were no longer available in the Southern Hemisphere. Two of the species (*harrisi* and *tonnoiri*) have typical disjunct relict populations but *neozelandica* and particularly *fuscinervis* are relatively widespread and abundant, the latter being one of the most conspicuous elements of the entire culicid fauna of New Zealand. All 4 species are very strongly differentiated in male genitalic characters including those of the phallosome and proctiger. Only *harrisi* is strongly differentiated in the larva and pupa and has a phallosome markedly different from the other 3 species and therefore may represent a separate phyletic line from the latter.

KEYS TO TRIBES AND GENERA

Adults

1. Antenna about twice as long as head and thorax combined; flagellar segments all cylindrical or filiform, basal one at least 10 times as long as wide (Paradixini). . . . . *Paradixa*
Antenna about as long as head and thorax combined; flagellar segments all more or less fusiform, basal one at most 5 times as long as wide (Dixini) 2

2(1). Vein R$_{2+3}$ branched; base of M$_{3+4}$ complete . . . . *Nothodixa*
Vein R$_{2+3}$ unbranched; base of M$_{3+4}$ broken (1. *minuta*) . . . . *Neodixa*

Male Genitalia

1. Penis filament absent; proctiger with sclerotized plates, cercal bristles 2-5, borne on a sclerotized process (Paradixini) . . . . . . *Paradixa*
Penis filament present; proctiger unsclerotized, cercal bristles numerous, borne on a large unsclerotized lobe (Dixini) . *Nothodixa*, *Neodixa*

Pupae

1. Pinna of trumpet narrowly slit all the way basad to apical constriction of inner tracheoid; antennal case not extending beyond basal third of wing case (Dixini). . . . . *Nothodixa*
Pinna of trumpet without slit; antennal case extending beyond distal 0.75 of wing case (Paradixini). . . . . *Paradixa*

Larvae

(*Neodixa* unknown)

1. Dorsum of abdominal segments with conspicuous ovoid rosettes of plumose spinules; none of the hairs of the prothorax reaching anterior border of head capsule (Dixini) . . . . *Nothodixa*

Dorsum of abdominal segments without rosettes of plumose spinules; some of the hairs of the prothorax projecting well beyond anterior border of head capsule (Paradixini) . . . . *Paradixa*

TRIBE DIXINI

Genus NEODIXA

1924. *Dixella* Tonnoir, 1924b:230(4 Dec). TYPE SPECIES: **D. minuta* Tonnoir, 1924b, New Zealand; original designation. Preoccupied by *Dixella* Dyar & Shannon, 1924(22 Oct).

1925. *Neodixa* Tonnoir, 1925:311. TYPE SPECIES: Automatically *Dixella minuta* Tonnoir, 1924, New Zealand. Substitute name for *Dixella* Tonnoir, 1924.

Neodixa of Belkin (1962:103).

Neodixa is characterized by the unbranched vein R_{2+3}. In all other respects the only known specimen (male holotype) fits the diagnosis of *Nothodixa* but is different from any species assigned to the latter genus. Edwards (1930: 101) suggested that the venational character of *Neodixa* might be an individual variation and considered it hardly necessary to separate it generically, but in deference to the opinion of Tonnoir he treated it as a distinct genus. I also prefer to retain *Neodixa* as a distinct genus with the original characterization until additional specimens are available for study and it can be determined whether or not the venational character is genetic.

1. *Neodixa minuta* (Tonnoir)

Fig. 26

1924. *Dixella minuta* Tonnoir, 1924b:230. TYPE: *Holotype ♂, Nelson, N. Z., from low shrub along creek, 18 Oct 1923, A. L. Tonnoir [NELS].

Neodixa minuta of Tonnoir (1925:311); Tillyard (1926:352); Edwards (1930a: 101; 1932:15); Taylor (1934:7); Cooper and Rapp (1944:252); Miller (1950: 46); Nowell (1951:241); Belkin (1962:103-104).

FEMALE. Unknown.

MALE: *Wing*: 2.5 mm. Body completely black, head and thorax shining and with very short bristles, abdomen dull and somewhat velvety. Maxillary palpus with segment 5 about twice as long as segment 4. Antenna about as long as head and thorax together; first 7 flagellar segments more or less fusiform and fairly distinct from one another, segments 8-14 filiform. Legs yellowish except for tips of femora and tibiae and the ends of the tarsi which are blackish; base of hindtarsal segment 1 ventrally with a spinelike bristle; claws pectinate. Wing (Tonnoir 1924b:fig. 8; Belkin 1962:fig. 34) dusky and unspotted, base and anterior border yellowish; vein Sc ending well basad of furcation of R and somewhat basad of middle of wing; vein R_{2+3} unbranched and not strongly arched; base of vein M_{3+4} obliterated. Haltere yellowish.

MALE GENITALIA (Tonnoir 1924b:figs. 9, 10; Belkin 1962:fig. 33). Similar to Nothodixa. Tergite IX with numerous bristles. Sidepiece and clasper simple. Phallosome apparently similar to Nothodixa. Proctiger simple and without spines; cercus very prominent and with numerous bristles.

PUPA and LARVA. Unknown.

SYSTEMATICS. The unique known specimen of Neodixa minuta is fully hardened, not teneral. Except for the aberrant venation it appears to be perfectly normal and agrees in general with the characteristics of described species of Nothodixa. The 2 aberrant features of the venation, unbranched R_{2+3} and broken base of M_{3+4}, are equally well developed on both wings. I have not seen any such aberrant venation in specimens of Nothodixa but have noted several aberrations in the venation, largely unilateral, in specimens of Paradixa from New Zealand, among them: base of R_2 broken (bilateral), apex of R_3 atrophied, apex of R_3 fused with R_{4+5}, partial atrophy of M_{3+4}.

I agree with Edwards (1930a:101) that the holotype of minuta represents a species distinct from any other New Zealand dixine. Its characters, other than the aberrant venation, do not agree with any described species of Nothodixa and it seems probable therefore that is not a dwarf sport of any of these. I believe also that the reduced venation of minuta is probably of a genetic nature and not an individual aberration as suggested by Edwards (loc. cit.). The fact that venational aberrations of the type present in minuta do occur rarely as individual variations in some lines does not preclude the genetic fixation of such an aberrant character in a particular phylad. Since in minuta the unbranched R_{2+3} is a unique exception to the characteristic venation of the entire family Culicidae in the broad sense, the tendency is to regard this as an individual variation as Edwards did. However, exceptions to characters of equal importance, at least at a subfamily level, can occur and are genetically fixed as is the case in the reduction in the normal number of flagellar segments in the antenna of Ethiopian species of Chaoborus (sen. lat.) notably in Neochaoborus anomalus (Edwards, 1930). Therefore, the possibility exists that the venational peculiarities of minuta are genetic and I prefer to regard them as such until the problem can be finally resolved when additional specimens become available for study.

BIONOMICS. The specimen was "obtained in sweeping with the net some low shrubs in a wet part of the track along the 'Reservoir' creek."

DISTRIBUTION (fig. 26). NEW ZEALAND. Nelson: Nelson, track along Reservoir creek, 18 Oct 1923, A. L. Tonnoir, ♂ holotype [NELS].

Genus NOTHODIXA

1930. Dixa (Nothodixa) Edwards, 1930:101. TYPE SPECIES: Dixa campbelli Alexander, 1922, New Zealand; original designation.

Nothodixa of Belkin (1962:100).

FEMALES (fig. 4). Head: Clypeus with numerous bristles distally, some of these laterally. Antenna about as long as head and thorax together; flagellar segments 1-5(6) more or less fusiform, segment 1 at most 3 times as long as maximum width. Thorax: Acrostichals usually extending caudad on prescutellar space; dorsocentrals extending to near parascutellum, posterior part of row curved laterad; notopleurals numerous; humerals usually few; fossals numerous; paratergite narrow, bare; parascutellum strongly developed but without bristles. Scutellum nearly perpendicular to mesonotum, usually a few bristles in the middle caudad of apical row; postnotum very large and bulging, bare. *Apn*, *ppn* and upper *mep* with bristles; *stp* below transverse suture with or without short inconspicuous light hairs; apparently no other pleural bristles or hairs present. *Legs*: Hindtibia very strongly swollen apically, comb poorly differentiated, a large ovoid depression just proximad of comb filled with numerous fused spicules which are continued in a narrow line ventrad at base of comb. Claws of all legs with spicules on outer surface. *Wing*: Membrane and veins dusky; microtrichia of membrane large and uniformly densely distributed. Vein Sc moderately well developed, its apex distinct and ending on C distinctly basad of furcation of R; crossvein *h* angled distad apically, a faint crossvein at level of *h* connecting Sc to base of R; cross vein *r-m* always at least its own length basad of furcation of Rs; crossvein *m-cu* distinct but weak; bristles on vein M basad of *r-m* varied. Alula with a marginal row of dorsal hairs only; margin of upper and lower calypters bare. *Haltere* long, winglike; apparently with 4 rows of bristles, 2 of them marginal. *Abdomen*: Spiracles present only on IV-VII. Sternite I without hairs. *Genitalia*: Segment VIII reduced, its tergite about half as long as that of VII, its sternite subequal to that of VII. Tergite IX small, poorly sclerotized; its lateral lobe short and separated from median part at least at base. Postgenital plate without distinct median sclerotization but with prominant hairy lateral lobes. No distinct bursa copulatrix; one large spermatheca in segment VII, its duct moderately long, with only 1 loop and with opening on sternite IX.

MALES. Essentially as in the females. Hindtarsal segment 1 with 4 heavy long spinelike bristles at base on ventral (lower) surface; extreme base of venter of all tarsal segments 5 with a strong bristle recurved apically. All claws enlarged and pectinate and with spicules externally.

MALE GENITALIA (fig. 7). *Segment VIII*: Tergite and sternite at least 0.7 as long as corresponding sclerites of segment VII. *Segment IX*: Lightly sclerotized, without internal ridge articulating with base of sidepiece. Tergite with bristles, much smaller than sternite, restricted to middle of dorsal surface and separated from sternite by membrane. Sternite very large, extending to dorsal surface, bristles restricted to the dorsal lobes. *Sidepiece* without conspicuous processes but with slight hairy subapical and median basal lobes. *Clasper* simple, without differentiated spiniforms. *Phallosome*: Figured in everted condition by Belkin (1962, fig. 33) and in normal retracted condition here (fig. 7); largely membranous. Prosophallus simple, deeply emarginate in the middle and with a pair of longitudinal sclerites to the aedeagal pouch, widely-spaced at base. Phallus with small aedeagal pouch which is papillose on inner surface; aedeagal sclerites forming a poorly sclerotized fused dorsal and dorsolateral cordate plate from whose thickened apex arises a short free penis filament within the aedeagal cup; aedeagal sclerites articulating with a long process of proximal division of basal piece on each side. Opisthophallus a simple large transverse lobe with poorly developed, weakly sclerotized lateral sclerites articulating with outer part of proximal division of basal piece but not with the proctiger. Distal division of basal piece strongly developed; proximal division represented chiefly by inner part (paramere) articulating with aedeagal sclerite, its outer part very poorly developed. *Proctiger* largely membranous, with indistinct basal sclerotizations; cercus a large, prominent lobe with many bristles.

PUPAE. *Cephalothorax*: Antennal case not extending beyond basal third of wing case. Hairs 2, 3, 4-C apparently all absent; hair 9-C usually far caudad near base of wing case, adjacent to hair x-C. Trumpet: Short and broad; pinna very broad and flaring, narrowly slit all the way basad to apical constriction of inner tracheoid; apical margin of pinna sinuate, with an evenly spaced row of simple hooks recurved mesad; external surface tracheoid to near pinna. Metanotum: Hairs 11, 12-C very close together in a depression; 10-C far mesad of 11, 12-C, its distance from the latter several times that between hairs 11 and 12. Abdomen: Hair 1-I-VII far mesad of hairs 2 and 3; hair 2-V-VII far cephalad of hairs 1 and 3; dorsal sensillum (s) associated with hair 4 on all segments. Paddle: Hair 1-P at level of base of genital lobe.

LARVAE. Head: Head capsule broad, length about 0.75 of maximum width or less, strongly emarginate middorsally on caudal border, a more or less distinct and deep emargination on caudal border ventrolaterally; tentorium very poorly developed, anterior arm very short, never reaching posterior; labial process narrow, triangular, pointed distally; collar not developed. Hairs 4, 5-C widely separated, distance between the 2 hairs 4-C subequal to or less than that between hairs 4 and 5 on one side; hairs 6, 9, 10-C near midlevel of head capsule; hairs 12, 13-C very close together, their alveoli adjoining; hairs 14, 15-C both single, 15-C at base of labial process. Antenna: Relatively short, about 0.5 of total head length; relatively straight, without marked curvature in basal half; shaft with triangular spinules only; hair 1-A inserted near apex, at about 0.8 from base; a clear alveolus (sensillum?) at about 0.7. Thorax: None of the prothoracic hairs more than 0.5 of entire thorax length, usually much shorter; hair 2-P at level of 1-P; hairs in group 2, 3-M, T adjoining, separated from each other by not more than width of 1 basal tubercle. Abdomen: Dorsum of II-VII with conspicuous oval rosettes of plumose spinules occupying large part of disc of each segment. Prolegs present on venter of I, II; with heavily sclerotized, pigmented hooks in 1 rank only on anterior border, other hooks poorly developed, lightly pigmented and sclerotized, and separated from the anterior row by a wide space. Ventral ambulacral combs on V, VI only, consisting on each segment of a pair of submedian oval areas with a single rank of 6-8 slightly hooked spines and corresponding internal sclerotized bars; the pair of oval areas not separated by median sclerotization; venter of VII with a prominent median caudal projection with dense spicules. Hair 1-I-V widely separated from hairs 2, 3; dorsal sensillum (s) associated with hair 4 throughout; hair 14-I laterad of hair 13; hair 11-II within the circlet of caudal hooks on proleg; hair 12-VII apparently absent; hair 10, 11-VII not reaching middle of segment VIII, hair 6-VII much shorter than hair 7; hairs 3-5-VIII short, none reaching apex of spiracular lobe. Spiracular Apparatus: Spiracles small, widely separated, distance between them more than twice length of one anterolateral lobe (without spicules). Anteromedian lobe with or without small sclerotized plate; hairs 4, 5-S closer to spiracle than to hair 3. Anterolateral lobe small, without conspicuous sclerotized median process mesad of spiracle. Median plate not developed, lateral sclerotizations small and not connected across midline, this area more or less densely and uniformly covered with short stellate spicules. Posterolateral lobe without apical ventral pointed process; hair 8-S very close to marginal spicules, hair 12-S on inner margin of lobe a considerable distance proximad of apex, hair 13-S on lobe, distad of hair 14. Pecten plate strongly sclerotized, with simple articulated marginal teeth and without spicules overlying their bases; hair 1-S simple, inserted in lower half of plate. Anal Segment: Basal saddle strongly developed, bearing hair 4c-X; hairs 4-X all short, at most subequal to length of posterolateral lobe of spiracular apparatus; supraanal spicules in several rows; caudal process not distinctly separated from the cylindrical process; hairs 1-3-X distinctly barbed, moderate in length, less than length of 2 abdominal segments.

SYSTEMATICS. The genus *Nothodixa*, as currently recognized, is a strongly differentiated group of true dixines that is restricted to the Southern Hemisphere and is known at present by 2 species in southeast Australia and Tasmania, 4 species in New Zealand and 4 species in Chile and Patagonia. All these species obviously belong to an assemblage distinct from the other generic group taxa currently recognized in the tribe Dixini except *Neodixa*. However, each of the above-mentioned areas appears to have 1 or 2 endemic groups of *Nothodixa*, some of which are so strikingly different in male genitalic and larval characters that they may have to be separated as distinct subgenera and possibly even genera. The relationships of the different regional groups cannot be determined at this time because of the extremely poor knowledge of the Australian and South American species and the still fragmentary knowledge of the New Zealand species.

In New Zealand the 4 known species fall into 2 distinct groups on the basis of wing spotting and infuscation. It seems probable that these groups are also characterized by larval differences. On the other hand, the 2 groups have extremely similar male genitalia and pupae.

The *campbelli* group, consisting of *campbelli* and *philpotti*, is characterized by spotted and infuscated wings and probably also by a larva with hooks similarly oriented and subequal in number on prolegs I and II. Contrary to an earlier suggestion (Belkin 1962:99), it appears now that in the *campbelli* group, *philpotti* is clearly distinct morphologically from the nominate species and is ecologically isolated from the latter. *N. campbelli*, as currently interpreted, has a wide distribution encompassing both South Island and North Island and is the commonest *Nothodixa* in New Zealand. There is no indication of geographical differentiation in this species on South Island and the Wellington area of North Island where adults have been collected. Farther north only larvae are known at present and these show only minor differences from those occurring on South Island.

The *otagensis* group, comprising *otagensis* and *septentrionalis*, is characterized by wings generally lacking conspicuous infuscations and probably also by a larva with hooks more numerous and longitudinally oriented on proleg I and less numerous and transversely oriented on proleg II. It is evident that the 2 forms have arisen as a result of geographical differentiation but because of the fragmentary nature of the available material it is not clear if this differentiation has reached the specific level. For the present they are regarded as distinct species.

Much work remains to be done on *Nothodixa* in New Zealand. The immature stages are unknown for *philpotti* and *otagensis*; the male of *philpotti* is unknown and so is the female of *septentrionalis*. Even for the best known species, *campbelli*, only about 50 adults have been collected or reared and none north of Wellington. Since there is some indication of both geographical and ecological differentiation in the known species and since the populations tend to be disjunct and very small, there is a distinct possibility of unrecognized species existing at present in New Zealand. The presence of populations of larvae of the *campbelli* group on Little Barrier and Great Barrier islands is evidence of the ability of at least one species of the genus either to disperse over moderate ocean barriers or to survive rather major environmental upheavals. A search should be made for similar isolated populations on other islands in the New Zealand area.

The apparent low density population structure, the relict disjunct distribution and the great uniformity of basic structure in all known species, including the aberrant *Neodixa*, suggest that the *Nothodixa* lineage has been in New Zealand a very long time, much longer than the *Paradixa* lineage. This may account for the dispersal of *Nothodixa* to South America at an early date by land connections through or near New Zealand and also for the absence of *Paradixa* in South America because of the absence of such connections later.

BIONOMICS. In New Zealand, *Nothodixa* seems to be much less common than *Paradixa* and its breeding sites appear to be more specialized and restricted. All collections of immature stages of *Nothodixa* to date have been in small streams in rather narrow steep valleys in hills and mountains and never in larger streams or in water courses in flat open valleys or plains. The 2 species whose larvae are definitely associated appear to differ in their preference for current strength and for light intensity, *campbelli* occurring in slower flowing water and in more open situations and *septentrionalis* in fast water in moderate to deep shade. Even in seemingly favorable habitats the populations of *Nothodixa* appear to be usually very small.

Nothodixa larvae can usually be recognized in the field by the projection of the abdominal rosettes above the water surface film. In collecting containers they tend to rest with the body straight and not bent into the U-shape characteristic of *Paradixa* larvae.

Keys to Species

Adults

1. Wing conspicuously spotted and infuscated along some veins 2
Wing usually without spots or infuscations, at most with a faint cloud on *r-m* only. 3

2(1). Vein R_{2+3} with only a marginal infuscation; vein M proximad of *m-cu* usually with an elongate dark streak . . . . 2. *campbelli*
Vein R_{2+3} with a large square or roundish blotch extending into cell R_1; vein M proximad of *m-cu* with a large restricted quadrate blotch. . . . . 3. *philpotti*

3(1). Vein M beyond *m-cu* subequal to vein M_{1+2}; mesonotum with reddish brown ground color and blackish median and posterolateral stripes. . . . . 4. *otagensis*
Vein M beyond *m-cu* about 1.5 or more of vein M_{1+2}; mesonotum uniformly brown, without distinct darker stripes . . . 5. *septentrionalis*

Male Genitalia

(2. *philpotti* not known)

1. Tergite IX with no more than 15 weak bristles; dorsal lobe of sternite IX with about 6 weak bristles. . . . . 2. *campbelli*
Tergite IX with at least 20 strong bristles; dorsal lobe of sternite IX with at least 10 strong bristles . . . . 4. *otagensis*; 5. *septentrionalis*

Pupae

Insufficiently known for separation, see 2. *campbelli* and 5. *septentrionalis*.

Larvae

(3. philpotti and 4. otagensis not known)

1. Proleg I not markedly larger than II and with 20-30 heavy pigmented hooks in a transverse arc as on proleg II, latter with 15-20 similar hooks; dorsum of thorax and abdominal segment I with heavy long spicules or spinules clearly visible at 100X . . . . . . 2. campbelli

Proleg I twice as large as II and with at least 50 heavy pigmented hooks in a longitudinal arc, proleg II with 20-30 similar hooks in a transverse arc; dorsum of thorax and abdominal segment I with minute fine spicules invisible at 100X . . . . 5. septentrionalis

2. Nothodixa campbelli (Alexander)

Figs. 4, 5, 25

1922. Dixa campbelli Alexander, 1922a:20-21. TYPE: Holotype ♂, Charteris Bay Banks Peninsula, Canterbury, N. Z., 4 Sept 1921, J. W. Campbell [ALEX].

Nothodixa campbelli of Belkin (1962:99-100).
Dixa (Nothodixa) campbelli of Edwards (1930a:101; 1932:11); Taylor (1934:7); Nowell (1951:233).
Dixa campbelli of Alexander (1922b:147); Tonnoir (1924b:224-225, 231-232); Tillyard (1926:352); Martini (1931:199, 203); Cooper and Rapp (1944:249); Miller (1950:45).

ADULTS (fig. 4). Wing: 3.3-3.5 mm. Forefemur: 1.2-1.4 mm. Abdomen: about 2.0 mm. As figured here and as described by Belkin (1962:99-100); with the following diagnostic features. General coloration yellowish marked with brown; legs yellowish with tips of femora and tibiae and entire tarsi dark. Thoracic bristles short and weak, light in color. Mesonotum yellowish, with a broad median dark stripe on anterior half and a pair of broad lateral dark stripes beginning about halfway between scutal angle and origin of wing and extending to scutellum. Stp apparently without hairs. Base of wing, including membrane, veins C, Sc, and R, yellow to level of crossvein h; a brown streak on M, a large brown blotch centered on r-m but not reaching furcation of R, and brown infuscations along R_{2+3}, R_{4+5}, M_{3+4} and Cu and its branches.

MALE GENITALIA (fig. 4). As figured here and as described by Belkin (1962:100). Very similar to otagensis and septentrionalis. Weakly sclerotized and with weak hairs and bristles. Tergite IX with 6-15 weak bristles, mostly in distal part. Dorsal lobe of sternite IX with 5-7 weak bristles.

PUPA (fig. 5). Abdomen: 3.3 mm. Trumpet: 0.2 mm. Paddle: 0.66 mm. General morphology and chaetotaxy as figured; very similar to septentrionalis from which it cannot be differentiated at present. Cephalothorax and metanotum uniformly moderately pigmented; trumpet uniformly moderately pigmented, a little brighter than cephalothorax; abdomen and paddle uniformly lightly pigmented.

LARVA (fig. 5). Head: 0.45 mm. Posterolateral Lobe: 0.34 mm. Anal Segment: 0.32 mm. General morphology and chaetotaxy as figured; diagnostic characters as in the key. Head: Uniformly moderately pigmented a brownish yellow except for blackish clypeal border, antennal tubercle, eye region, caudolateral and caudomesal areas, and posterior border. Hair pigmentation moderate to strong; hair 4-C projecting far cephalad of clypeal border, the 2 hairs 4-C usually distinctly closer together than hairs 4, 5-C on one side. Antenna uniformly very darkly pigmented, blackish. Thorax: Dorsum of posterior part of prothorax and all of meso- and metathorax with large heavy spicules, sometimes with shorter spinules. Hairs moderately to strongly pigmented, particularly on dorsum; at least hair 4-P longer than head capsule. Abdomen: Dorsum of segment I with spicules or spinules similar to those on dorsum of thorax. Dorsal hairs of segment I strongly pigmented and heavy as on thorax. Disc within the rosettes of segments II-VII with heavy, darkly pigmented, broad, apically-branched spicules with distinct sclerotized basal area; distance between bases of spicules mostly subequal to length of spicules, rarely more than twice their length. Proleg I only slightly larger than proleg II, with 20-30 pigmented heavy hooks; proleg II with 15-20 similar hooks. Hairs on all segments moderately pigmented and moderately long. Spiracular Apparatus: Anteromedian lobe without sclerotization; hair 13-S very heavy, usually nearly straight; pecten teeth usually heavy. Anal Segment: Hair 4b-X about as thick as hair 4-C and usually longer than latter.

SYSTEMATICS. N. campbelli seems to be the only widespread and the commonest species of Nothodixa in New Zealand. I have examined adults from all the land districts of South Island except Marlborough and Southland, and also from the vicinity of Wellington. In this larger series of adults the same wide range of coloration of the body and infuscation of the wing was found as was noted earlier (Belkin 1962:100). This variation is neither geographical nor ecological, the whole range occurring in different localities and in different individuals reared from the same breeding site. Perhaps most of the variation is due to differences in the stage of hardening or to the age of the individuals. I am convinced that the adults I have seen represent only one species and that there is no geographical subspecific differentiation within the range encompassed by these specimens.

I have included provisionally under campbelli all larvae of Nothodixa with strong spiculation of the thoracic dorsum and with the hooks similarly oriented and subequal in number on prolegs I and II. There is considerable variation in several characters in these larvae and the possibility exists that 2 or more species are represented in this sample. Only through association of stages by individual larval rearings can the problem be resolved.

The unassociated whole larvae of campbelli from the type locality and all the collections on South Island except Black Gully (Otago) conform quite well to the description given above which is based on larval skins associated with individual adults. There is some variation in the distance between head hairs 4-C, in the length of prothoracic hairs, and in the length and spacing of the dorsal thoracic spicules. The latter may be due primarily to unequal wear of the spicules and to differences in the stretching of the integument in larvae of different sizes.

The larvae from Black Gully (Otago), the southernmost reported locality for Nothodixa, at first glance appear to be strikingly different from typical campbelli in the much shorter and more widely spaced dorsal thoracic spicules, the space between the bases of the spicules being usually 3 times or more the length of an individual spicule. In addition the thoracic and abdominal hairs are usually considerably shorter, anal hairs 4-X are shorter and weaker, and the spicules within the abdominal rosettes are shorter and more widely spaced. There is considerable variation in all these characters in the small series of larvae (9) but there does not seem to be any significant overlap with typical *campbelli*. Furthermore, hair 13-S on the posterolateral lobe of the spiracular apparatus is considerably longer than in typical *campbelli* and is apically recurved, a condition never encountered in the latter. It is possible that all of these differences are individual environmental modifications induced by the swifter current in which these larvae were found, and that therefore we are dealing here with an extreme ecotype of *campbelli*. I suspect, however, that this is a different species, either an undescribed one or *philpotti* which probably breeds in swifter streams than *campbelli* and should have a larva in general similar to the latter. Had these larvae been found in a locality where *philpotti* is known, I would not hesitate to assign them provisionally to that species.

The 9 larvae of the *campbelli* type known from 6 different localities on North Island, 2 of them in association with *septentrionalis*, also differ from typical *campbelli* but in fewer features than the larvae from Black Gully. The chief differences are in the shorter and more widely spaced dorsal thoracic spicules (longer than in Black Gully population), smaller spicules within the rosettes, and somewhat longer hair 13-S, which however is nearly straight. These differences are so minor that it seems unlikely that a species different from *campbelli* exists on North Island. However, this possibility should not be dismissed and an effort should be made to rear material from the North Island populations to resolve the problem.

BIONOMICS. The immature stages of *campbelli* have been found most frequently along the margins of very small tributaries of streams in rather narrow steep valleys, never along the margins of larger streams or in flat open valleys. In several instances the water courses used by *campbelli* have been mere trickles or even small residual pools without detectable flow. The immature stages have been found also along the grassy margins of small streams with slow to moderate current but no specific information was obtained as to the strength of the current in the exact location where the larvae were found. Concentration of larvae and pupae have been found in flotage blocking the flow of water. The general impression is that this species prefers quiet water and that it can utilize quiet pools or marginal pockets in streams with considerable current. On South Island *campbelli* is frequently found associated with *Paradixa fuscinervis* but the latter has a much wider range of breeding sites. On North Island *campbelli* has been found together with *septentrionalis* in 2 collections but it is probable that *campbelli* was utilizing quieter water.

Adults of *campbelli* have been collected in small swarms over a stream (Alexander 1922a:21).

DISTRIBUTION (fig. 25). Material examined: 531 specimens; 14 ♂; 37 ♀; 422 larvae; 58 pupae; 31 individual rearings (20 larval, 3 pupal, 8 incomplete).

NEW ZEALAND. North Auckland: Mangamuka Gorge, 2 mi N of Soda Spring, 21 Dec 1963, BS (NZ 41), 1 l (41-102) [UCLA]; elev. ca 500 m, 18 Feb 1965, F (NZ 205), 2 L [UCLA].

Little Barrier Island: Stream between Te Waikohare and Tirikikawa, elev. 7 m, 6 Mar 1964, S (NZ 128), 1 L [UCLA].

Great Barrier Island: Port Fitzroy, 12 Mar 1964, S (NZ 138), 1 L [UCLA].

South Auckland: Te Aroha, Stoney Creek, 26 Mar 1964, S (NZ 139), 2 L [UCLA].

Gisborne: Urewera National Park, Hopuruahine area, Orangihikoa stream, elev. 2450 ft, 30 Mar 1964, S (NZ 141), 2 L [UCLA].

Wellington: Wilton Bush (as Welton's Bush), Mar, A. L. Tonnoir, A [Tonnoir 1924b]. Day's Bay, 29 Nov 1921, A. L. Tonnoir, 1 A [NELS].

Nelson: North Branch Riwaka River, 4 Jan 1964, BG (NZ 75), 1 lp♀ (75-101), 3 lP (75-102-104), 23 L, 2 ♀ [UCLA]. Pokororo, 19 Dec 1921, A. L. Tonnoir, 1 A [NELS]. The Glen, 12 Mar 1964, S (NZ 168), 1 lp♀ (168-103), 1 p♂ (168-104), 10 L, 4 P [UCLA]. Nelson, junction of Maitai River and Sclanders stream, 11 Feb 1964, S (NZ 135), 2 L [UCLA]; South Branch Maitai River, 11 Feb 1964, S (NZ 127), 1 lp♂ (127-102), 1 lP (127-104), 11 L [UCLA]. Nelson, 8 Apr 1922, A. L. Tonnoir, 2 A [NELS], 1 ♀ [CANT]; 27 June 1922, A. L. Tonnoir, 1 ♀ [CANT]; 10 Aug 1922, A. L. Tonnoir, 1 A [NELS]; 18 Oct 1923, A. L. Tonnoir, 1 ♂ [CANT]. Dodson's Valley, elev. ca 68 m, 12 Mar 1964, S (NZ 165), 2 lp♀ (165-101, 103), 1 lp♂ (165-105), 2 lP (165-102, 104), 85 L, 6 P, 1♀ [UCLA]. Aniseed Valley, 5 Jan 1964, BG (NZ 79, 80), 10 lp♀ (79-101-107; 80-102-104), 75 L, 8 P, 1 ♂, 4 ♀ (79), 40 L, 2 P (80) [UCLA]. New Creek Rd, between Murchison and Kawatiri Junction, 8 Feb 1964, S (NZ 116), 1 L [UCLA].

Westland: Lake Brunner, Feb, A. L. Tonnoir, L [Tonnoir 1924b]. Kumara, 15 Sept 1929, J. W. Campbell, 1 ♀ [USNM], 1 ♀ [UCLA]; 6 Nov 1929, J. W. Campbell, 4 ♂, 1 ♀ [USNM], 1 ♀ [UCLA]. Waiho, 27 Jan 1922, A. L. Tonnoir, 1 ♂, 1 ♀ [NELS].

Canterbury: Cass, 30 Nov 1924, A. L. Tonnoir, 1 ♂ [CANT]. Christchurch, July, A. L. Tonnoir, A [Tonnoir 1924b]. Governors Bay, 27 Sept 1923, J. F. Tapley, 1 ♂ [BMNH]; 3 Jan 1964, BD (NZ 72), 3 lp♀ (72-102, 103, 109), 1 lP (72-105), 80 L, 2 P [UCLA]. Charteris Bay, 4 Sept 1921, J. W. Campbell, ♂ holotype [ALEX, not seen], 6 ♂ paratypes [CANT]. Hilltop, 14 Jan 1925, A. L. Tonnoir, 1 ♀ [CANT].

Otago: Ben Lomond, 2 Feb 1964, S (NZ 111), 1 p♂ (111-101), 1 p♀ (111-103), 51 L, 6 P [UCLA]. Black Gully, 31 Jan 1964, S (NZ 109), 9 L [UCLA].

3. Nothodixa philpotti (Tonnoir)

Fig. 25

1924. Dixa philpotti Tonnoir 1924b:227-228. TYPE: *Holotype ♀, Nelson, South Island, N. Z., sweeping along mountain creek, 5 Dec 1921, A. L. Tonnoir [NELS].

Nothodixa philpotti of Belkin (1962:100-101).
Dixa (Nothodixa) philpotti of Edwards (1932:11); Taylor (1934:7); Nowell (1951:239).
Dixa philpotti of Cooper and Rapp (1944:251); Miller (1950:46).

FEMALE (Tonnoir 1924b:fig. 3; Belkin 1962:fig. 34). Wing: 3.5 mm. Forefemur: 1.5 mm. Abdomen: about 2.5 mm. In general similar to campbelli but darker in coloration and with the following diagnostic features. Thoracic bristles dark; light coloration of mesonotum yellowish orange, brown stripes more extensive than in campbelli; pleuron largely dark, yellowish orange along mesonotal border and above hindcoxae. Femora infuscated in the middle and with a subterminal ring of distinctly lighter coloration; tibiae and tarsi entirely dark. Base of wing dusky, only slightly lighter than rest; blotch on r-m large, extending all the way to furcation of R; vein M proximad of m-cu with a large quadrate blotch extending well into cell R; vein R_{2+3} with a large quadrate or roundish blotch extending well into cell R_1; veins R_{4+5}, M_{3+4}, Cu and its branches, and anal margin of wing with broad lines of infuscation; vein Sc strong but relatively shorter, ending on C before 0.7 of distance between crossvein *h* and furcation of R, with bristles on distal part; vein Rs beyond *r-m* about 1.5 of *r-m* length; vein R_{2+3} very strongly arched at base, usually with a stump vein in blotch in middle of curvature; distal part of Cu_1 strongly recurved. Haltere usually infuscated on stem.

MALE and PUPA. Unknown.

LARVA. Unknown but probably of the type of the Black Gully (Otago) population briefly described in the section on SYSTEMATICS under *campbelli*, which may possibly belong to *philpotti*.

SYSTEMATICS. In general morphology and particularly wing infuscation, *philpotti* comes closest to *campbelli* and I consider that these 2 forms constitute a distinct group. I am convinced that *philpotti* is a species distinct from *campbelli* since in the additional material of both forms that I have examined there is no indication of intergradation. Of the 5 specimens of *philpotti* that I have seen only the one in BMNH lacks the stump vein on R_{2+3}. *N. philpotti* is probably a derivative of the *campbelli* group adapted for breeding in fast flowing water.

BIONOMICS. This species probably breeds in fast flowing mountain streams as all known adults have been "collected by sweeping the plants along mountain creeks with a much swifter flow of water than in those the Dixa larvae usually breed" (Tonnoir 1924b:228). The larvae from Black Gully (Otago) mentioned above were apparently collected in such a situation and may possibly belong to this species.

DISTRIBUTION (fig. 26). Material examined: 5 ♀.

NEW ZEALAND. *Nelson*: Nelson, 18 Oct 1923, A. L. Tonnoir, 1 ♀ paratype [CANT]; 5 Dec 1921 (not 15 Dec), A. L. Tonnoir, ♀ holotype [NELS]; 15 Dec 1921, A. L. Tonnoir, 1 ♀ paratype [NELS], 1 ♀ paratype [BMNH]. Mt. Arthur, elev. 4000 ft, 24 Dec 1921, A. L. Tonnoir, 1 ♀ [NELS]. This species has not been found definitely in any other locality but it is possible that it has a wider distribution since larvae from Black Gully (Otago) listed and discussed under *campbelli* may actually belong to *philpotti*.

4. *Nothodixa otagensis* (Alexander)

Figs. 7, 26

1922. *Dixa otagensis* Alexander, 1922b:147. TYPE: Holotype ♂, Ben Lomond, Otago, N. Z., 30 Dec 1921, G. Howes [ALEX].

Nothodixa otagensis of Belkin (1962:101-102).

Dixa (Nothodixa) otagensis of Edwards (1932:11); Taylor (1934:7); Nowell (1951: 239).

Dixa otagensis of Tonnoir (1924b:225-226); Cooper and Rapp (1944:251); Miller (1950:45).

ADULTS (Tonnoir 1924b:fig. 11; Belkin 1962:figs. 32, 34). *Wing*: 5.0 mm. *Forefemur*: 2.0 mm. *Abdomen*: about 2.5 mm. As described by Belkin (1962: 101); in general similar to *campbelli* but wing without conspicuous infuscations and with the following diagnostic features. General coloration brown to reddish brown. Thoracic bristles moderately long, all dark except those on *stp*; ground color of mesonotum reddish brown, with broad median and posterolateral longitudinal stripes. Wing membrane without infuscations except for a faint cloud on *r-m* (indistinct or apparently completely absent in dry specimens);

furcation of R_{2+3} at level of middle of Cu_1; vein M beyond *m-cu* at most equal to M_{1+2}; furcation of M distinctly basad of level of end of Cu_1.

MALE GENITALIA (fig. 7). As figured; in general very similar to *campbelli* and *septentrionalis*. Moderately sclerotized and with strong hairs and bristles. Tergite IX with 26-28 bristles, more or less evenly distributed. Dorsal lobe of sternite IX with 12, 13 bristles.

PUPA and LARVA. Unknown; probably of the *septentrionalis* type.

SYSTEMATICS. After examination of additional material, I agree with Tonnoir (1924b:227) that *otagensis* and *septentrionalis* should be treated as distinct but closely related species and I am recognizing the *otagensis* group for these 2 species. Our present knowledge of both species is still very inadequate and fragmentary and it is possible, as originally suggested by Tonnoir (loc. cit.), that the 2 forms are merely geographical races of 1 species. Whether or not this is the case can be determined only when material of the group becomes available from the area between the widely disjunct known distributions of the 2 forms.

The differences in size, color of thorax and in wing venation mentioned in the diagnosis are quite distinct. In *otagensis* there is little individual variation in these characters except for 1 specimen which shows the extreme condition in the shortness of R_{2+3} and M beyond *m-cu* illustrated by Tonnoir (1924b:fig. 11), and which was marked by him with a manuscript name (see DISTRIBUTION below). This type of variation in the southernmost locality of *otagensis* may have suggested to Tonnoir that farther north there might be the reverse trend toward the condition in *septentrionalis* in wing venation as well as in other characters.

Whatever the taxonomic status of *otagensis* and *septentrionalis* actually is, it is evident that in the *otagensis* group there has been geographical differentiation within a single lineage. This appears to be the only clear-cut instance of this phenomenon in the Culicidae of New Zealand.

BIONOMICS. Nothing is known of the bionomics of *otagensis*; even the circumstances of the collections of adults are not recorded. If *otagensis* and *septentrionalis* are truly closely related, it is very likely that the immature stages of *otagensis* will be found in fast flowing small streams similar to those used by *septentrionalis*.

DISTRIBUTION (fig. 26). Material examined: 8 specimens; 5 ♂, 2 ♀, 1 A sex undetermined.

NEW ZEALAND. *Westland*: Waiho, 28 Jan 1922, A. L. Tonnoir, 1 A [NELS]. *Canterbury*: *Christchurch*, Jan 1922, J. W. Campbell, 1 ♂, 1 ♀ [BMNH]. *Otago*: Glenorchy, 3 Jan 1923, C. C. Fenwick, 1 ♂ [BMNH]. Ben Lomond, 30 Dec 1921, G. Howes, ♂ holotype, 1 A [ALEX, not seen]. Queenstown, 1 Feb 1922, A. L. Tonnoir, 2 ♂ (1 marked type "meridionalis"), 1 ♀ [NELS], 1 ♂ [CANT].

5. *Nothodixa septentrionalis* (Tonnoir)

Figs. 6, 7, 26

1924. *Dixa septentrionalis* Tonnoir 1924b:226-227. TYPE: *Holotype ♂, Te Aroha, South Auckland, N. Z., from rock at foot of waterfall, 28 Feb 1923, A. L. Tonnoir [NELS].

Nothodixa septentrionalis of Belkin (1962:102).
Dixa (Nothodixa) septentrionalis of Edwards (1932:11); Taylor (1934:7); Nowell (1951:239).
Dixa septentrionalis of Cooper and Rapp (1944:251); Miller (1950:46).

FEMALE. Unknown.

MALE (Tonnoir 1924b:fig. 5; Belkin 1962:fig. 34). *Wing*: 3.5 mm. *Forefemur*: 1.5 mm. *Abdomen*: about 2.5 mm. As described by Belkin (1962: 102); similar to *otagensis* but differing from it in the following diagnostic features. General color uniformly brown, mesonotum without distinct dark longitudinal stripes. Thoracic bristles stronger than in *otagensis*. Wing membrane entirely without infuscations, no cloud on *r-m*; furcation of R_{2+3} at level of apex of Cu_1 or beyond; vein M beyond *m-cu* at least 1.5 of M_{1+2}; furcation of M distad of level of apex of Cu_1.

MALE GENITALIA (fig. 7). As figured; in general very similar to *campbelli* and *otagensis*. Lightly sclerotized but with strong hairs and bristles. Tergite IX with 20-21 bristles, more or less evenly distributed. Dorsal lobe of sternite IX with 10, 11 bristles.

PUPA (fig. 6). *Abdomen*: 3.5 mm. *Trumpet*: 0.3 mm. *Paddle*: 0.66 mm. General morphology and chaetotaxy as figured; very similar to *campbelli* from which it cannot be differentiated at present. Cephalothorax and metanotum uniformly moderately pigmented; trumpet uniformly moderately pigmented; a little brighter than cephalothorax; abdomen and paddle uniformly lightly pigmented.

LARVA (fig. 6). *Head*: 0.46 mm. *Posterolateral Lobe*: 0.34 mm. *Anal Segment*: 0.32 mm. General morphology and chaetotaxy as figured; diagnostic characters as in the key; in general similar to *campbelli* from which it differs chiefly in the following. *Head*: Uniformly lightly pigmented a clear yellow except for same darkened areas. Hairs shorter, more slender and usually lighter in color; hair 4-C barely projecting cephalad of clypeal border, the distance between the 2 hairs 4-C usually subequal to or greater than between 4, 5-C on one side. *Thorax*: Dorsum with numerous minute spicules arranged in short transverse rows, practically invisible at 100 X. Hairs shorter and lighter in coloration; all hairs, including 4-P, shorter than head capsule. *Abdomen*: Dorsum of segment I with minute spicules as on thorax. Dorsal hairs of segment I lightly pigmented and short as on thorax. Disc within the rosettes of segments II-VII with much smaller, lightly pigmented, broad, apically-branched spicules without distinct sclerotized basal area; distance between bases of spicules at least 3 times length of spicules. Proleg I more than twice as large as proleg II, with 50 or more pigmented hooks arranged in a longitudinal arc; proleg II with 20-30 hooks arranged in a transverse arc. Hairs on all segments shorter and lighter in color. *Spiracular Apparatus*: Anteromedian lobe with distinct small sclerotization, bearing hair 3-S on each side; hair 13-S longer and not as heavy, its distal part distinctly recurved; pecten teeth usually smaller. *Anal Segment*: Hair 4b-X much thinner and usually shorter than hair 4c.

SYSTEMATICS. *N. septentrionalis* differs from *otagensis* chiefly in size, color and wing venation. It is treated here as a distinct species but it may possibly be only a geographical race of *otagensis* (see). However, in the small series of adults (7) there is no overlap of diagnostic characters with the latter species.

BIONOMICS. The immature stages of *septentrionalis* have been found in small mountain or hill streams with moderate to strong current. This species seems to prefer moderate to deep shade and the margins of streams with strong current. In collecting containers, the larvae rest more frequently with the body fully extended than in the U-bend characteristic of most dixids. As indicated under *campbelli*, 2 collections of *septentrionalis* included a few larvae of the former but it seems probable that these were collected in quieter water.

The male adults of the type series were all collected on rocks at the foot of a waterfall.

DISTRIBUTION (fig. 26). Material examined: 84 specimens; 7 ♂, 3 pupae, 74 larvae; 2 larval individual rearings (1 incomplete).

NEW ZEALAND. *South Auckland*: Te Aroha, 28 Feb 1923, A. L. Tonnoir, ♂ holotype, 3 ♂ paratypes [Nels], 1 ♂ paratype [CANT, I·292], ♂ paratype [BMNH]. Stoney creek, 26 Mar 1964, S (NZ 139), 1 lp♂ (139-101), 1 lP (139-102), 50 L [UCLA].

Gisborne: Urewera National Park, Hopuruahine area, elev. ca 2900 ft, 27 Dec 1963, BS (NZ 56), 2 L [UCLA]; Hopuruahine area, Orangihikoa stream, elev. 2450 ft, 30 Mar 1964, S (NZ 141), 20 L, 1 P [UCLA].

TRIBE PARADIXINI

Genus PARADIXA

1924. *Dixa (Paradixa)* Tonnoir, 1924b:222. TYPE SPECIES: **Dixa neozelandica* Tonnoir, 1924, New Zealand; selection of Edwards 1932:9.

Paradixa of Belkin (1962:105-106).
Dixella in part of Lane (1951); Nowell (1963); Hubert (1965); Peters and Cook (1966).

FEMALES (figs. 1, 8). *Head*: Clypeus with a few bristles apically, in the middle only. Antenna at least 1.5 as long as head and thorax together; flagellar segments all elongate, cylindrical or filiform, segment 1 at least 8 times as long as wide. *Thorax*: Acrostichals usually extending caudad on prescutellar space; dorsocentrals extending to near parascutellum, posterior part of row curved laterad; notopleurals usually 2-3; humerals usually numerous; fossals 1-2; paratergite narrow, bare; parascutellum strongly developed but without bristles. Scutellum nearly perpendicular to mesonotum, without bristles caudad of apical row; postnotum very large and bulging, bare. *Apn* and *ppn* with a few bristles, *stp* without hairs; apparently no other pleural bristles or hairs present. *Legs*: Hindtibia moderately swollen apically, comb strongly differentiated, a narrow longitudinal ridge just proximad of comb, apparently consisting of fused spicules which are continued in a narrow line ventrad at base of comb. Claws of all legs with spicules on outer surface. *Wing*: Membrane and veins dusky; microtichia of membrane large and uniformly densely distributed. Vein Sc usually strongly developed and with bristles (except in *tonnoiri*), its apex ending on C at or near level of furcation of R; cross vein *h* angled distad apically, a faint crossview at level of *h* connecting Sc to base of R; crossvein *r-m* at or a short distance (less than own length) distad of furcation of Rs; crossvein *m-cu* very weak, sometimes indistinct; bristles on vein M basad of *r-m* varied. Alula with a marginal row of dorsal hairs only; margin of upper and lower calypters bare. *Haltere* long, winglike; apparently with 4, 5 rows of bristles, 2 of them marginal. Abdomen: Spiracles present only on IV-VII. Sternite I without hairs. Genitalia: Segment VIII large, its tergite subequal to that of VII, its sternite enlarged, about twice as long as that of VII. Tergite IX large, dorsal part strongly or weakly sclerotized; its lateral lobe joined to median part at least at base. Postgenital plate strongly sclerotized in middle and projecting as a triangular process beyond the small hairy lateral lobes. A distinct bursa copulatrix present in all species, with strong internal sclerotizations; 1 large spermatheca in segment VII, its duct varied in length and with opening in dorsal wall of bursa.

MALES. Essentially as in the females. Hindtarsal segment 1 without differentiated spinelike bristles at base on ventral (lower) surface; tarsal segments 5 without specialized recurved bristle at base. All claws enlarged and with spicules externally; those of foreleg and midleg pectinate; those of hindleg simple or with 1 tooth only.

MALE GENITALIA (fig. 7). Segment VIII: Tergite and sternite about 0.5 of corresponding sclerites of segment VII. Segment IX: More or less strongly sclerotized and forming a complete ring. No membrane separating tergite from sternite; boundary of tergite indicated by internal ridge on each side far ventrad which provides a sternal articulation for sidepiece. Sternite thus restricted to ventral surface, with bristles. Tergite with or without median dorsal caudal lobe, with bristles. Sidepiece with or without conspicuous lobes. Clasper irregular in shape, with more or less distinct processes or lobes; several to many spiniforms present. Phallosome: Very complex and with strong sclerotizations. Prosophallus strongly developed and usually heavily sclerotized (except in harrisi); formed by a prosophallic sclerite continuous across midline sternally but usually interrupted by a membrane on midline of tergal surface (except in harrisi in which it encloses an unsclerotized median area). Phallus with large broad shallow aedeagal pouch; penis filament not developed; aedeagal sclerites broad, not distinctly separated from central part of proximal division of basal piece; separated from each other on midline by membrane and not joined tergally. Opisthophallus very strongly developed; lateral sclerite articulated with outer angle of outer part of the proximal division of basal piece and with the base of the proctiger; with projecting spines or processes. Distal division of basal piece moderately developed; proximal division very strongly developed, with both a central part continuous with aedeagal sclerites and a strongly sclerotized outer part articulating with opisthophallus. Proctiger very prominent and complex, articulating at base with opisthophallus; heavily sclerotized at base and bearing 1 or more spinelike processes with heavy apical spiniforms; median portion, bearing anus, membranous; cercus represented by more or less prominent lobe bearing 2 or more simple setae.

PUPAE. Cephalothorax: Antennal case extending beyond distal 0.75 of wing case. Hair 2-C apparently always absent; hair 1-C apparently sometimes absent; hair 3-C always well developed; hair 4-C always present; hair 9-C usually near 8-C not x-C. Trumpet: short and broad; pinna narrow or broadened but always without slit; apical margin of pinna smooth or sinuate, with evenly-spaced row of rather broad crenulations hooked mesad; external surface tracheoid at base only. Metanotum: Hairs 11, 12-C very close together in a depression; position of hair 10-C varied. Abdomen: Hair 1-I-VI near hairs 2 and 3; hair 2-V-VIII near level of hairs 1 and 3; dorsal sensillum(s) associated with hair 3 on all segments. Paddle: Hair 1-P at level of base of genital lobe or distad.

LARVAE. Head: Head capsule relatively longer than in Nothodixa, its length about 0.9 of maximum width or more, less strongly emarginate middorsally on caudal border, no distinct emargination on caudal border ventrolaterally; tentorium strongly developed, anterior arm very long, reaching posterior; labial process broad, truncate or rounded distally; collar more or less strongly developed. Hairs 4, 5-C close together, distance between the 2 hairs 4-C twice or more that between hairs 4 and 5 on one side; hairs 6, 9, 10-C in posterior half of head capsule; hairs 12, 13-C separated from each other by several times width of their alveoli; hairs 14, 15-C both branched, 15-C near middle of labial process. *Antenna*: Relatively long, about 0.6 or more of total head length; distinctly concave mesad in basal half; ventral surface with short triangular spinules replaced by hairlike spicules distad of hair 1-A toward inner margin; hair 1-A inserted in basal 0.67; subapical clear alveolus apparently absent. *Thorax*: Some of the prothoracic hairs as long as entire thorax; hair 2-P near level of 3-P; hairs in groups 2, 3-M, T widely separated, distance between them several times width of 1 basal tubercle. *Abdomen*: Dorsum of segments without rosettes of plumose spinules. Prolegs present on venter of I, II; with heavily sclerotized pigmented hooks in 2 ranks, other small lighter hooks immediately adjacent caudad. Ventral ambulacral combs on V-VIII consisting on each segment of a pair of submedian straight lines of 6-8 slightly hooked spines in 1 rank and corresponding internal sclerotized bars; the pair of lines separated by a small median sclerite; venter of VII without prominent median caudal projection. Hair 1-I-V widely separated from hairs 2, 3; dorsal sensillum(s) associated with hairs 2, 3 throughout; hair 14-I mesad of hair 13; hair 11-II caudad of hooks on proleg; hair 12-VII present; at least hair 11-VII extending beyond middle of segment VIII, hair 6-VII at least 0.67 of hair 7; hairs 3-5-VIII long, at least 1 of these reaching apex of spiracular lobe. *Spiracular Apparatus*: Spiracles relatively larger than in *Nothodixa* and less widely spaced, distance between them not more than 1.5 length of 1 anterolateral lobe (without spicules). Anteromedian lobe with a forked basal sclerotization; hair 3-S on the forks, hairs 4, 5-S closer to hair 3 than to spiracle. Anterolateral lobe moderately large, with a conspicuous sclerotized median process mesad of spiracle. Median plate with 2 paired and 1 unpaired median plates developed; the paired ones continuous with lateral plates, all plates with sharp simple spinules; membranous area between them with thin hairlike spicules. Posterolateral lobe with apical ventral pointed process; hair 8-S removed ventrad from lateral spicules, hair 12-S near apex of lobe, hair 13-S not on lobe proper, basad of hair 14. Pecten plate usually poorly sclerotized, with complex branched marginal spicules or spinules and with smaller complex spicules overlying their bases; hair 1-S always forked or branched, inserted near the middle of plate or in upper half. *Anal Segment*: Basal saddle moderately developed, not bearing any hairs; hairs 4-X all much longer than posterolateral lobe of spiracular apparatus; supraanal spicules in 1 rank only; caudal process more or less distinctly separated from cylindrical process; hairs 1-3-X without conspicuous barbs, longer than combined length of 2 abdominal segments.

SYSTEMATICS. I am not accepting the synonymy of *Paradixa* with *Dixella* Dyar and Shannon, 1924 (22 Oct; type species *D. lirio* Dyar and Shannon, 1924, from Panama) which was first proposed by Lane (implied in 1949:257; stated in 1951:336) and which has been followed by Nowell (1962), Hubert (1965), and Peters and Cook (1966), apparently in every case without examining in detail the respective type species. Only 2 other paradixine generic group taxa have been proposed, both monotypic, *Dixapuella* Dyar and Shannon, 1924 (*D. marginata* Loew, 1863, Washington, D.C.), and *Dixina* Enderlein, 1963 (*D. ob-*

scura Loew 1849, Europe). No serious attempt at a classification of the paradixines has ever been made and the tendency has been to describe species primarily on the basis of wing color pattern and venation and superficial structures of the male genitalia (clasper and sidepiece specializations), and to lump them all into 1 genus. Peters and Cook (1966) described what I believe to be the significant features of the phallosome and proctiger of the males but did not figure them or use them to group species. It is evident that on the basis of these structures at least 3 distinct major phylads were included in their concept of *Dixella*, possibly one of them congeneric with *lirio* and another with *neozelandica*. This view is supported by differences I have noted in the larvae of a few species from California.

For the present I am characterizing *Paradixa* primarily on the features of the male phallosome and proctiger listed above in the diagnosis of the genus. In addition to the 4 New Zealand species treated here the genus includes 2 species from Tasmania (*tasmaniensis* and *unipunctata*) and 2 species from New South Wales (*nicholsoni* and *humeralis*) all described by Tonnoir (1924a). No other species can be definitely assigned to *Paradixa* at this time but it appears that this genus may be represented by several forms in the Holarctic region. No species of *Paradixa* nor any paradixine at all is known from Patagonia and South Chile. None of the "neotropical" species of *Dixa* (*Dixella*) of Lane (1953) appears to be a true *Paradixa*.

The New Zealand species of *Paradixa* fall into 2 groups on the basis of characters of the male genitalia, larvae and pupae. The single known species in the *harrisi* group appears to have a relict population structure and is currently known only on North Island. The *neozelandica* group includes 3 species, one of which, *tonnoiri*, appears to have a relict population structure and is known only on South Island. The other 2 species of the group, *neozelandica* and *fuscinervis*, are dominant modern forms with nearly identical wide distributions throughout both North Island and South Island. The 3 species of the *neozelandica* group are obviously derivatives of the same stock; their larvae and pupae are very similar and the only striking differences are in unique specializations of the male genitalia. Each species has a distinct wing pattern but the differences are primarily in the extent and density of infuscation.

There is no gross ecological differentiation in species of *Paradixa* in New Zealand, the 4 species usually occurring sympatrically, even in the same breeding site, *tonnoiri*, *neozelandica* and *fuscinervis* on South Island, and *harrisi*, *neozelandica*, and *fuscinervis* on North Island. There is no indication of geographical differentiation in the 2 dominant modern species while the allopatric distributions of *tonnoiri* and *harrisi* involve members of 2 different groups. The complexity and unique development of the structures of the phallosome and proctiger of the male genitalia in each species coupled with lack of ecological differentiation and with sympatric occurrence suggest that in these forms the effective mechanism of species separation is a mechanical barrier in mating. This interpretation is supported by the fact the females of all species possess a complex bursa copulatrix with an apparently unique development of internal sclerites in every species. It would be interesting to study these in detail to see if there is a "lock and key" correspondence of the female and male genitalia in every species.

The analyses presented in the preceding paragraphs suggest the following pattern of evolution and speciation of *Paradixa* in New Zealand. First, the problem of whether 1 or 2 lineages entered New Zealand cannot be resolved definitely at this time because I have not seen extralimital material to determine the possible presence of the *harrisi* and *neozelandica* groups elsewhere in the World. However, Tonnoir's illustrations and descriptions suggest that none of the described Tasmanian and Southeast Australian species belongs to either group. Therefore, for the present, I am postulating that only 1 lineage of *Paradixa* reached and survived in New Zealand. Since *tonnoiri* possesses the largest number of generalized features in the male genitalia and in the larva I believe that this species is closest to the original stock. The first derivative was *harrisi* and it was formed probably in geographical isolation somewhere in the area of the present-day North Island very soon after the arrival of *Paradixa* in New Zealand. Further speciation was apparently restricted to the *neozelandica* group and probably occurred much later. *Neozelandica* and *fuscinervis* may have arisen contemporaneously as a result of a tripartite geographical isolation of the *tonnoiri* stock and later become sympatric when the isolated areas were reunited. However, *fuscinervis* may have arisen at a later date than *neozelandica* either from the latter or from *tonnoiri*; the dominance of *fuscinervis* might be interpreted as evidence in support of more recent origin of this species. There is no way to localize the place of origin of either *fuscinervis* or *neozelandica* since they have nearly identical distributions and since relative abundance and dominance would lead to ambiguous conclusions.

As indicated under *Nothodixa*, I believe that the absence of *Paradixa* from Patagonia and South Chile where *Nothodixa* is strongly represented is probably due to a later dispersal of *Paradixa*, at a time when no suitable land bridges existed between New Zealand-Australia and southern South America.

BIONOMICS. In New Zealand, *Paradixa* is much more common than *Nothodixa* probably because the range of its breeding sites is much wider. Almost all types of fresh ground waters are utilized except large rivers and the swiftest small streams. Two of the species, *neozelandica* and *fuscinervis*, are conspicuous elements of the culicid fauna of New Zealand. However, even these widely distributed species usually have very small populations.

Paradixa larvae can usually be distinguished from *Nothodixa* in the field by the lack of abdominal rosettes projecting above the water surface film. In natural habitats they normally rest on the edges of the breeding sites with the body bent in a U, only the head and tail ends in the water. The larvae are capable of crawling out of water and can move rapidly on the surface film by a backward looping motion. Pupae can swim but are most frequently found partially or completely out of water but, of course, surrounded by a water film. Emergence of the adult takes place from the pupa completely out of the water. Both sexes can be found resting on vegetation in shaded protected places around the breeding sites. In the laboratory they live only a few days. Males of some species fly in small swarms, usually near sunset. Eggs are laid on the edge of the water in a gelatinous mass in which the first instar larvae remain up to 24 hours (Forsyth 1968). The aquatic cycle is completed in about 4 weeks in the laboratory.

Keys to Species

Adults

1. All veins in distal part of wing, particularly R_{4+5}, with distinct broad marginal infuscations . . . . .7. *fuscinervis*
Veins in distal part of wing at most with very narrow indistinct marginal infuscations 2

2(1). Wing without blotch on r-m and base of branches of radial sector . . . . 8. *tonnoiri*
Wing with more or less distinct blotch on r-m and base of branches of radial sector 3

3(2). Wing blotch small, invading only apex of cell R, otherwise confined to vein margins . . . . 6. *neozelandica*
Wing blotch large, invading apex of cell R, base of cells R_5 and R_3 and projecting into cell R_1. 9. *harrisi*

Male Genitalia

1. Sidepiece with a winglike claspette lobe developed from the mesosternal margin . . . . 9. *harrisi*
Sidepiece without winglike claspette lobe 2

2(1). Sidepiece with a prominent elongate basal tergomesal lobe bearing a heavy apical spiniform . . . . 6. *neozelandica*
Sidepiece without prominent elongate basal tergomesal lobe 3
3(2). Subapical lobe of sidepiece with at least 1 dark spiniform; clasper with only a basal lobe bearing several dark spiniforms . . .7. *fuscinervis*
Subapical lobe of sidepiece without any dark spiniforms; clasper with both a basal and a median lobe each bearing several dark spiniforms . . . . 8. *tonnoiri*

Pupae

1. Pinna of trumpet widely flared apically; paddle hair 1-P at level of base of genital lobe . . . . 9. *harrisi*
Pinna of trumpet narrow apically, not flared; paddle hair 1-P at level beyond middle of genital lobe . . . . 6. *neozelandica*; 7. *fuscinervis*; 8. *tonnoiri*

Larvae

1. Ventrocaudal border of pecten plate with 3-5 very large dark teeth fused at base; pecten hair 1-S irregularly dendritic; anal segment short, subequal to length of posterolateral lobe of spiracular apparatus . . . . 9. *harrisi*
Ventrocaudal border of pecten plate with separate teeth subequal to those elsewhere; pecten hair 1-S forked or 2, 3-branched; anal segment long, at least 1.25 length of posterolateral lobe of spiracular apparatus 2

2(1). Dorsum of thorax without any spicules visible at 100X; antenna much darker than head capsule . . . . .7. *fuscinervis*
Dorsum of thorax with distinct spicules visible at 100X; antenna concolorous with or lighter than head capsule 3

3(2). Basal postpecten spines very large and dark; no differentiated apical postpecten spicule . . . . 6. *neozelandica*
Basal postpecten spines very small, light in color; a conspicuous differentiated apical postpecten spicule . . . . 8. *tonnoiri*

6. Paradixa neozelandica (Tonnoir)

Figs. 1, 8, 9, 27

1924. Dixa neozelandica Tonnoir, 1924b:228-229. TYPE: *Holotype ♂, Aniseed Valley, Nelson, N. Z., from small rivulet, 21 Mar 1922, A. L. Tonnoir [NELS].

Paradixa neozelandica of Belkin (1962:106-107).
Dixa (Paradixa) neozelandica of Tonnoir (1925:311); Edwards (1932:14); Taylor (1934:7); Nowell (1951:238).
Dixa neozelandica of Cooper and Rapp (1944:251); Miller (1950:45).

ADULTS (figs. 1, 8; Tonnoir 1924b:fig. 2; Belkin 1962:figs. 32, 34). Wing: 3.0-4.25 mm. Forefemur: 1.4-1.75 mm. Abdomen: about 1.75-2.25 mm. As figured here and as described by Belkin (1962:106-107) except for the following corrections and diagnostic features. General coloration brown with a variable amount of lighter, yellowish markings. Wing with an inconspicuous dilute cloud on r-m restricted to vein margins and apex of cell R but not invading cell R_1; no distinct marginal infuscations on other veins, although some of them, particularly Rs and base of Cu appear darker. Head capsule, including entire clypeus, dark brown; flagellar segment 1 about 12 (11-13) times as long as wide and about 1.7 of length of segment 2. Mesonotum light brown on disc and prescutellar space, dark brown in front and sides, margined with lighter yellow color on humeral angle and above pleuron; pleuron dark in the center and below, lighter (yellowish) on upper part along mesonotum and wing base and along a band from forecoxa to metapleuron; thoracic bristles strong, dark. Legs brown to light brown, apices of femora and tibiae darkened; distal part of forecoxa and all of midcoxa and hindcoxa whitish. Haltere largely light, somewhat darkened in middle part of stem.

MALE GENITALIA (fig. 8; Tonnoir 1924b:fig. 7; Belkin 1962:fig. 33). As figured here and as described by Belkin (1962:107), with the following corrections and diagnostic features. Sidepiece: A prominent slender short apical lobe bearing distally 2-4 short heavy spiniforms and several bristles, some thickened; a prominent thumblike basal mesal lobe bearing apically a long, very heavy dark spiniform. Clasper with poorly indicated submedian lobe bearing numerous spiniforms, latter present also distally toward apex of clasper. Phallosome: Prosophallic sclerite very broad, hollowed out in the center on median projecting lobe. Aedeagal sclerites narrow near base, elongate on distal part which is bent at an angle of about 90° cephalad. Proximal division of basal piece very broad. Opisthophallus with a prominent spiculose lateral sclerite bearing a thumblike process at its inner proximal angle and a slender fingerlike straight process with an apical spiniform from the middle of its mesal margin. Proctiger: Sclerotizations restricted; a heavily sclerotized small basal ventrolateral plate produced on its caudomesal angle into a very long slender process which bears an apical spiniform and is recurved at base so that it projects behind proctiger's apex; a poorly sclerotized dorsolateral plate bearing spicules ventrally and produced at its dorsolateral angle into a long slender spinelike process strongly recurved cephalad distally and bearing an apical spiniform and 2-5 subapical cercal bristles.

PUPA (fig. 9). Abdomen: 3.1 mm. Trumpet: 0.21 mm. Paddle: 0.73 mm. General morphology and chaetotaxy as figured; diagnostic characters as in the key; indistinguishable from fuscinervis and tonnoiri. Cephalothorax uniformly moderately to lightly pigmented throughout; dorsal surface, except on midline, with small sparse tubercles; hairs moderately pigmented. *Trumpet* more or less barrel-shaped, not widened apically, variable in length; uniformly moderately pigmented, a little brighter than cephalothorax. *Abdomen* uniformly lightly to moderately pigmented; tubercles indistinct except laterally; hairs moderately pigmented. *Paddle* moderately pigmented; serrations of internal and external margins variable; hair 1-P somewhat variable in position but always distad of level of middle of genital lobe.

LARVA (fig. 9; Tonnoir 1924b:figs. 12A, 12D). *Head*: 0.48 mm. *Posterolateral Lobe*: 0.35 mm. *Anal Segment*: 0.50 mm. General morphology and chaetotaxy as figured; diagnostic characters as in the key; very similar to *fuscinervis* and *tonnoiri*. *Head*: Uniformly moderately pigmented a clear brownish yellow except for darkened antennal tubercle and patches of darkened areas caudomesad, and black collar; hair pigmentation moderate; hair 11-C usually with 2, 3 forks. *Antenna* uniformly moderately pigmented, concolorous with general surface of head capsule. *Thorax*: Dorsum of posterior part of prothorax and all of meso- and metathorax with short thickened spicules clearly visible at 100X and shorter than distance between their bases; sides of all segments with spicules longer, finer and densely packed; venter of prothorax with very fine long spicules very densely packed except for posterior part where they are thickened and more widely spaced; venter of meso- and metathorax with very fine short spicules densely packed in short transverse lines except on anterior part of mesothorax where they are similar to those on posterior part of prothorax; hairs heavily to moderately pigmented, all single. *Abdomen*: Spiculation of segment I as on metathorax; spiculation of segments II-VI largely restricted to midventral areas, spicules progressively longer and more numerous on distal segments, particularly proximad of ambulacral combs on each segment, dorsal intersegmental areas with shorter heavier spicules; segments VII, VIII with sparse spicules evident on the sides and dorsum in addition to the usual long dense ventral spiculation as on preceding segments. Prolegs I, II each with about 15-19 large dark hooks in anterior row. Ambulacral combs with about 7 large spines on each side of median sclerite on segments V, VI and about 5, 6 spines on segment VII. Hairs strongly to moderately pigmented. *Spiracular Apparatus*: Hair 13-S about as long as posterolateral lobe, rather thin and attenuate apically. Pecten plate moderately to lightly pigmented, with sparse hairlike spicules in basal part; posterior margin with a row of large teeth mostly with 2 subequal spines; proximad of these teeth 2 rows of broad apically fringed spicules; 2, 3 very large black basal postpecten spines arising from a large basal sclerite; apical postpecten spicule not developed; pecten hair 1-S 2-branched or 2-forked. *Anal Segment*: Unsclerotized part of segments IX, X with dense long spiculation on venter as on preceding segments; sclerotization uniformly moderately pigmented except for darkened base of saddle and apex of process; a few light hairlike spicules on basal saddle and longer similar spicules on entire surface of caudal process; length of entire sclerotized part about 1.4-1.5 of posterolateral lobe; postanal spicules relatively short, less than twice the length of cylindrical process.

SYSTEMATICS. Adults of *neozelandica* are usually readily distinguished from all other New Zealand dixids by the characteristic infuscation around *r-m* of the wing. *P. harrisi* has a somewhat similar infuscation but it is larger and more intense than in *neozelandica*. *P. tonnoiri* apparently lacks this infuscation but as noted under this species this may be due to the teneral condition of the 4 known specimens. The degree of infuscation in *neozelandica* varies considerably; in addition to the weak cloud on *r-m* there are more or less distinct infuscations on the distal part of nearly all the veins and at the base of Cu, but these infuscations rarely approach the condition in *fuscinervis* and there is no difficulty usually in separating the 2 species because of the much larger and denser cloud on *r-m* in *fuscinervis*. The variation in wing infuscation in *neozelandica* does not appear to be correlated with differences in ecological or geographical origin of the samples. In the series of *neozelandica* from the colony established by Forsyth (1968) a number of striking anomalies in the wing venation have been noted, primarily unilateral, as indicated under *Neodixa minuta*. I have not seen any such anomalies in adults reared from larvae collected in nature. As in the case of other species of New Zealand *Paradixa*, the male genitalia of *neozelandica* are very characteristic. There is no significant variation in the unique development of the phallosome and proctiger complexes. On the other hand, the lobes and spiniforms of the sidepiece and the spiniforms of the clasper show a great deal of variation within a single population but as in the case of wing characters there is no indication of ecological or geographical differentiation in these structures. *P. neozelandica* differs from all other New Zealand paradixines in the development on the sidepiece of a prominent basal lobe with a heavy apical spiniform. The main body of the lateral sclerite of the opisthophallus of *neozelandica* is very strongly developed as a prominent spiculate lobe extending laterad. This lobe is homologous with differently developed structures in *fuscinervis* and *tonnoiri* but is completely different from the claspettelike lobe developed from the sidepiece in *harrisi*.

The larva of *neozelandica* is very similar to *fuscinervis* and particularly *tonnoiri* from which it is differentiated primarily by the presence of very strongly developed and very dark postpecten spines arising from a distinct basal sclerite. *P. fuscinervis* has similar but much smaller and lighter postpecten spines and in addition has dark antennae and lacks distinct thoracic spiculation. There is considerable variation in the development of the pecten teeth and basal postpecten spines in *neozelandica* but no significant overlap in the latter character with the other 2 species and no indication of anything but individual variation for both characters.

P. neozelandica is undoubtedly closely related to *fuscinervis* and *tonnoiri* as indicated by basic similarity in all stages, all 3 species being strikingly differentiated only in the male genitalia. In extent of geographical and ecological range and in abundance and dominance, *neozelandica* approaches *fuscinervis*. This may indicate that it was the second derivative of this lineage, the *neozelandica* complex.

BIONOMICS. *P. neozelandica* has nearly as wide a range of natural breeding sites as *fuscinervis* but appears to be less common. It has been collected in pools, ponds and swamps more frequently than *fuscinervis* and this may indicate that it has a preference for quieter water. Several collections are known from streams with moderate to fast general current but it is possible that in such situations *neozelandica* breeds in the quieter parts of the streams. The light conditions in the breeding sites ranged from deep shade to full sunlight. In all but 8 of the total of 50 larval collections, *neozelandica* was associated with *fuscinervis*. *P. neozelandica* was found in 3 of the 4 larval collections of *tonnoiri*, in 6 of 10 collections of *harrisi*, in 7 of 17 collections of *Nothodixa campbelli*, but never with *Nothodixa septentrionalis*.

P. neozelandica apparently does not penetrate into mountainous areas as much as *fuscinervis*, but like *fuscinervis* it has taken advantage of man-made habitats. It has been collected in ditches and has been found in experimental ponds at the Mangere Sewage Treatment Plant in Auckland. As in the case of *fuscinervis*, the larval populations of *neozelandica* are usually small and only a few adults are found resting in the vegetation surrounding the breeding sites.

P. neozelandica is the only dixine colonized to date (Forsyth 1968). In this colony, maintained for 5 generations, females oviposited within 72 hours of emergence and without taking any food. From 25 to 78 eggs were enclosed in a single circular gelatinous mass which was attached to the walls of the tank at the water level. The larvae hatched after 4 days but remained in the gelatinous matrix up to 24 hours before swimming out. The aquatic cycle lasted an average of 30 days at 20°C and the adults lived on the average only 4 days.

DISTRIBUTION (fig. 27). Material examined: 1324 specimens; 101♂, 166♀, 3 adults, 902 larvae, 152 pupae; 131 individual rearings (82 larval, 43 pupal, 6 incomplete).

NEW ZEALAND. *North Auckland*: Mangamuka Gorge, 2 mi N of Soda Spring, 21 Dec 1963, BS (NZ 41), 1 lp♂ (41-111), 2 lp♀ (41-107, 110), 5 L [UCLA]; same data (NZ 42), 1 ♂ [UCLA]. Dome Valley, 2 Jan 1965, F (NZ 198B), 1 ♂, 2 ♀ [UCLA]. Mangawhai Heads, elev. 12 m, 2 Jan 1965, F (NZ 198A), 1 ♀, 3 L [UCLA]. Mahurangi Heads, Martins Bay, elev. 3 m, 26 Dec 1964, F (NZ 196), 2 lp♂ (196-102, 103), 1 lp♀ (196-101), 1 lp (196-104), 1 ♀ [UCLA]; 29 Dec 1964, F (NZ 197), 2 lp♀ (197-101, 103), 1 p♀ (197-102), 1 L [UCLA]. Albany, Rosedale Road, elev. 100 m, 18 May 1964, F (NZ 182), 1 lp♀ (182-123), 1 lp (182-121), 4 L [UCLA]. Bethells Road Swamp, 10 Jan 1965, F (NZ 200B), 1 p♂ (200B-101), 1 p♀ (200B-102), 1 ♂, 2 ♀, 2 L [UCLA]; 12 Jan 1965, F (NZ 202), 1 ♂, 1 ♀, 1 L [UCLA]. Waitakere Ranges, edge of Cascade Park, 18 Dec 1963, BS (NZ 35), 4 L [UCLA]; elev. 20 m, 15 Nov 1964, F (NZ 195B), 2 L [UCLA]. Nihotupu, 23 Feb 1923, A. L. Tonnoir, 1 A [NELS]. Titirangi Beach, 30 Dec 1963, BS (NZ 64), 6 lp♀ (64-102, 103, 105-108), 1 ♂, 2 ♀, 17 L, 5 P [UCLA]; 11 Jan 1964 (NZ 94), 1 lp♀ (94-105), 1 p♂ (94-104), 1 p♀ (94-102), 86 L [UCLA]. Titirangi, French Beach, elev. 5 m, 4 July 1964, F (NZ 192), 1 ♂, 2 L [UCLA]. Mangere Sewage Treatment Plant, 9 Mar 1965, F (NZ 209A, B, C), 1 lp♂ (209B-102), 17 lp♀ (209B-101, 103-111, 114, 115, 123, 126-129), 4 p♂ (209B-113, 116, 119, 120), 7 p♀ (209B-112, 117, 118, 121, 122, 124, 125), 3 ♂, 3 ♀ (209A), 30 L, 1 P (209B), 30 ♂, 38 ♀, 10 L, 5 P (209C) [UCLA]; Mangere Purification Plant, experimental pond A, 15 June 1965, F (NZ 215), 1 lp♀ (215-11), 1 p♂ (215-10) [UCLA]; same data except experimental pond B (NZ 216A), 1 lp♀ (216A-110), 5 p♂ (216A-100-102, 104, 109), 5 p♀ (216A-103, 105-108), 1 ♂, 1 ♀ [UCLA]. Avondale, elev. 60 m, 23 Nov 1964, F (NZ 216B), 1 lp♀ (216B-102), 1 p♀ (216B-101), 15 ♂, 5 ♀ [UCLA]. Tuakau, elev. ca 10 m, 9 June 1964, F (NZ 190), 2 L [UCLA].

Little Barrier Island: Waipawa stream, 75-100 ft from mouth, 6 Mar 1964, S (NZ 130), 1 lp♂ (130-101), 5 lp♀ (130-102-104, 107, 108), 1 p♂ (130-105), 1 p♀ (130-106), 2 ♂, 2 ♀, 40 L, 3 P [UCLA]. Hut Bay Creek, near sea level, 8 Mar 1964, S (NZ 134), 1 L [UCLA].

Great Barrier Island: Port Fitzroy, 12 Mar 1964, S (NZ 138), 42 L [UCLA].

South Auckland: Coromandel, 25 Apr 1964, N (NZ 221), 25 L [UCLA]. Te Aroha, 10 mi S, 5 June 1965, F (NZ 211), 2 lp♀ (211-100, 102), 1 p♂ (211-103), 1 ♀, 14 L [UCLA].

Gisborne: Ormond, Waihirere Domain, 25-26 Dec 1963, BS (NZ 48), 2 lp♀ (48-109, 114), 1 p♀ (48-103), 34 L [UCLA]; 28 Mar 1964, S (NZ 140), 1 lp♀ (140-102), 2 p♂ (140-101, 104), 1 lp (140-105), 10 L [UCLA]. Hexton, bridge H20, S16-41, 26 Dec 1963, BS (NZ 50), 1 lp♂ (50-112), 5 lp♀ (50-113-117), 12 L [UCLA].

Wellington: Manunui turnoff between Piriaka and Taumarunui, 7 June 1965, F (NZ 213), 1 lp♂ (213-104), 2 lp♀ (213-101, 103), 1 p♀ (213-105), 1 L [UCLA]. Piriaka, elev. 200 m, 5 Jan 1965, F (NZ 199), 1 lp♀ (199-102), 2 L [UCLA]; 28 Mar 1965, F (NZ 210), 2 ♂ [UCLA]. Pokaka, 10 Jan 1964, BFS (NZ 86), 8 L [UCLA]. Ohakune, Mountain Road, 9 Jan 1964, BFS (NZ 83), 11 L [UCLA]; pond on bend of Lake Road, 9-10 Jan 1964, BFS (NZ 85B), 4 lp♂ (85B-108, 110, 113, 120), 10 lp♀ (85B-102, 104-107, 109, 115-118), 2 p♂ (85B-112, 114), 3 p♀ (85B-101, 103, 111), 1 lp (85B-119), 1 ♂, 179 L, 3 P [UCLA]; Rangataua Reserve Lake, elev. 600 m, 6 June 1965, F (NZ 212A), 1 ♀ [UCLA]; Ohakune, 8 Mar 1923, A. L. Tonnoir, 1 ♂ [BMNH], Mar 1923, T. R. Harris, 1 ♂ [BMNH], May-July 1923, T. R. Harris, 1 ♀ [BMNH], Feb 1924, T. R. Harris, 1 ♀ [BMNH].

Nelson: The Glen, 12 Mar 1964, S (NZ 168), 1 lp♀ (168-101), 8 L [UCLA]. Wakapuaka, Glen Road, 12 Mar 1964, S (NZ 167), 2 L [UCLA]. Maitai River, near Pole Ford Bridge, 14 Mar 1964, S (NZ 170), 9 L [UCLA]; at Smith's ford, 14 Mar 1964, S (NZ 171), 9 L [UCLA]. Nelson Reservoir, 12 Mar 1964, S (NZ 162), 7 L [UCLA]. Nelson, near DSIR, 3 Jan 1964, B (NZ 73A & B), 4 ♂, 4 L [UCLA]. Nelson, 3 Dec 1921, A. L. Tonnoir, 2 ♂ paratypes (I·293, I·294) [CANT]; 30 Oct 1923, A. L. Tonnoir, 1 A paratype [NELS]. Annesbrook, elev. ca 20 m, 10 Mar 1964, S (NZ 158), 1 lp♀ (158-101), 7 L [UCLA]. Blick's Valley, 12 Mar 1964, S (NZ 164), 1 p♂ (164-101), 9 L [UCLA]. Dodson's Valley, elev. ca 68 m, 12 Mar 1964, S (NZ 165), 3 L [UCLA]. Todd's Valley, 12 Mar 1964, S (NZ 166), 1 lp♀ (166-102), 6 L [UCLA]. Aniseed Valley, 21 Mar 1922, A. L. Tonnoir, ♂ holotype, 1 ♂, 2 ♀ paratypes [NELS]; 5 Jan 1964, BG (NZ 80), 3 lp♀ (80-106-108), 19 L [UCLA]. Howard Junction, 13 Mar 1964, S (NZ 169), 17 L [UCLA]. Gowanbridge, 9 Feb 1964, S (NZ 122), 5 L [UCLA]. Gowan River, road to Lake Rotoroa, 9 Feb 1964, S (NZ 121), 2 p♀ (121-101, 102), 90 L [UCLA]. New Creek Road, between Murchison and Kawatiri Junction, 8 Feb 1964, S (NZ 116), 1 L [UCLA].

Westland: Hercules Mt, S of Harihari, 7 Feb 1964, S (NZ 115), 1 lp (115-109), 1 L [UCLA]. Whataroa, 7 Feb 1964, S (NZ 114), 8 L [UCLA].

Canterbury: Christchurch, 28 Nov 1924, 1 ♀ [USNM]. Purau Creek, 20 Feb 1922, A. L. Tonnoir, 1 ♀ paratype [NELS], 1 ♀ paratype [CANT]. Timaru, Scenic Reserve, 24 Jan 1964, S (NZ 100), 3 lp♀ (100-103, 104, 114), 1 lp (100-110), 8 L [UCLA].

Otago: Waianakarua River near bridge of main road, 25 Jan 1964, S (NZ 102), 1 lp♀ (102-120), 1 lp (102-122), 66 L [UCLA]. Dunedin, Blackhead, 23 Feb 1964, N (NZ 217), 1 ♂, 2 ♀, 7 L [UCLA]. Queenstown, Ben Lomond, 2 Feb 1964, S (NZ 111), 1 L [UCLA].

New Zealand, location uncertain: Horseshoe Lake, 11 Nov 1924, 1 ♀ [USNM].

7. Paradixa fuscinervis (Tonnoir)

Figs. 7, 10, 28

1924. Dixa fuscinervis Tonnoir, 1924b:229-230. TYPE: *Holotype ♂, Nelson, N. Z., from small rivulet, 5 Sept 1922, A. L. Tonnoir [NELS].

Paradixa fuscinervis of Belkin (1962:109-110).
Dixa (Paradixa) fuscinervis of Edwards (1932:14); Taylor (1934:7); Nowell (1951:234).
Dixa fuscinervis of Cooper and Rapp (1944:249); Miller (1950:45).

ADULTS (Tonnoir 1924b:fig. 4; Belkin 1962:fig. 34). Wing: 3.5-4.7 mm.

Forefemur: 1.7-1.9 mm. Abdomen: about 2.2-2.5 mm. As described by Belkin (1962:109); extremely similar to neozelandica and differing almost entirely in wing ornamentation. Distal part of all veins from R to Cu_2 with rather broad marginal infuscations, particularly strong and wide on Cu_2 and M_{3+4}; all of Cu, base of 1A and hind margin of wing with more or less broad marginal infuscations; a large conspicuous dark blotch on r-m extending across furcation of Rs into cell R and almost touching vein R_1. Somewhat larger than neozelandica and usually lighter in coloration; clypeus usually lighter apically; length and proportions of flagellar segments similar; mesonotum light brown on entire disc except for darker restricted supraalar stripes (no median or anterior darkening); lateral mesonotal and pleural markings essentially similar to neozelandica; thoracic bristles weaker and lighter. Legs lighter in color, coxae similar to neozelandica.

MALE GENITALIA (fig. 7; Tonnoir 1924b:fig. 6; Belkin 1962:fig. 33). As figured here and as described by Belkin (1962) with the following corrections and diagnostic features. Sidepiece: A short apical lobe bearing 1 or more slender spiniforms and several bristles apically; no basal mesal lobe; no basal tergal bristles. Clasper with a conspicuous submedian lobe bearing about 10 short blunt spiniforms distally; shaft distad of lobe without spiniforms. Phallosome: Prosophallic sclerite narrower at base than in neozelandica, with a very prominent long outstanding median process hollowed out on its posterior face. Aedeagal sclerite essentially as in neozelandica but more heavily sclerotized and broader throughout. Proximal division of basal piece less strongly developed. Lateral sclerite of opisthophallus narrower, rugose laterally but not spiculose; its proximal process shorter, broader; its distal process shorter, stouter, curved and arising farther distad. Proctiger: With strong basal ventrolateral sclerotization from which arises first a very long slender curved spinelike process bearing an apical spiniform, more distally a shorter similar spinelike process, and cephalad of the latter and at about same level a short sclerotized thumblike truncate process bearing 2 widely separated apical cercal bristles.

PUPA (fig. 10). Abdomen: 3.4 mm. Trumpet: 0.25 mm. Paddle: 0.79 mm. General morphology and chaetotaxy as figured; diagnostic characters as in the key; indistinguishable from neozelandica and tonnoiri. Cephalothorax uniformly moderately pigmented; tubercles apparently larger and more numerous than in neozelandica; hairs lightly pigmented, difficult to see. Trumpet more or less barrel-shaped, not widened apically, variable in length; uniformly moderately pigmented, somewhat brighter than cephalothorax. Abdomen moderately to lightly pigmented, sometimes slightly darker laterally; tubercles indistinct except laterally; hairs lightly pigmented. Paddle uniformly moderately pigmented; serrations of internal and external margins variable; hair 1-P distad of level of middle of genital lobe.

LARVA (fig. 10; Tonnoir 1924b:fig. 12C). Head: 0.53 mm. Posterolateral Lobe: 0.33 mm. Anal Segment: 0.43 mm. General morphology and chaetotaxy as figured; diagnostic characters as in the key; very similar to neozelandica and tonnoiri, differing from the former primarily in the following features. Head capsule lighter in color. Antenna moderately pigmented, concolorous with basal tubercle and markedly darker than general coloration of head capsule. Thoracic and abdominal spiculation poorly developed, indistinct except on venter of thorax and distal abdominal segments; dorsum of thorax without visible spiculation at 100X. Hair 13-S somewhat shorter than posterolateral lobe of spiracular apparatus. Pecten plate lightly pigmented, poorly differentiated from unsclerotized part of segment, without distinct basal spicules; marginal pecten teeth weaker and shorter; basal postpecten spines developed but weaker, straighter and lighter in color, usually 1 or 2. Anal sclerotization much more lightly pigmented but darkened in the middle, length about 1.3 of posterolateral lobe; basal saddle without distinct spicules; caudal process shorter, spicules restricted to sides; postanal spicules about twice as long as cylindrical process.

SYSTEMATICS. Adults of *fuscinervis* are usually readily distinguished from all other New Zealand dixids by the characteristic infuscation of the wing. *Nothodixa campbelli* and *N. philpotti* have somewhat similar patterns of wing infuscation but are easily separated by striking differences in wing spotting and also by the short antennae. As indicated under *neozelandica*, that species has more or less distinct narrow marginal vein infuscations in addition to a small cloud on *r-m* but in spite of considerable variation in wing infuscation in *fuscinervis* there is no significant overlap between the 2 species. The most reliable character to separate them is the much larger and denser cloud on *r-m* in *fuscinervis*. The variation in wing infuscation in *fuscinervis* is strictly individual and does not correlate with any differences in ecology or distribution. I have not noted any striking anomalies in the wing venation of *fuscinervis* in a relatively large series. The male genitalia of *fuscinervis* have the greatest development of the phallosome and proctiger complex of any New Zealand *Paradixa* but basically are of the type found in *neozelandica* and *tonnoiri*. There is no significant variation in the unique development of any of these structures and particularly in the very prominent median process of the prosophallus, the very large aedeagal sclerite, and the very broad rugose lateral sclerite of the opisthophallus and its spines. On the other hand, as in *neozelandica*, there is a great deal of variation in the development of the apical lobe of the sidepiece and the submedian lobe and spiniforms of the clasper. These variations are also strictly individual and do not correlate with differences in ecology or geographical origin of the different populations.

The larva of *fuscinervis* is very similar to *neozelandica* and *tonnoiri* but is readily separated from both by the very dark antennae and the absence of conspicuous spiculation on the thorax. There is considerable variation in the pigmentation and development of the pecten teeth and spicules and particularly in the development of the basal postpecten spines. The latter, however, are always much smaller and lighter in color than in *neozelandica* and much larger than in *tonnoiri* and there is no significant overlap with either species. This variation of the pecten structures is, as in the other species of the complex, strictly individual.

As indicated under *neozelandica*, *P. fuscinervis* is closely related to this species and to *tonnoiri*. It is the dominant species of the *neozelandica* complex and the dominant dixid of New Zealand. Compared to the other widespread species (*neozelandica*), it has a somewhat wider geographical distribution, a distinctly wider range of breeding sites, and usually predominates in numbers in mixed populations. This suggests that it is the latest, most modern derivative of the *neozelandica* complex.

BIONOMICS. *P. fuscinervis* has the widest range of breeding sites of all New Zealand culicids. It has been found in all types of fresh ground waters, in streams, seepages, pools, ponds, lakes and even swamps. Twice it was found breeding in a fire barrel in association with *Culex pervigilans* and *C. quinquefasciatus* (NZ 45, 66). *P. fuscinervis* apparently prefers slow-moving or still water but is also found in streams with moderate or even strong current. It is most commonly found in partial shade but has also been collected frequently in full sunlight and more rarely in deep shade. *P. fuscinervis* has been found in association with all the other dixids whose immature stages are known, most frequently with *neozelandica*, but in about half of some 80 larval collections of *fuscinervis* no other dixid was present. In mixed collections *fuscinervis* is usually the dominant species.

P. fuscinervis occurs in the hills and mountains as well as in broad valleys, plains and coastal areas. It has adapted well to changes in the environment brought about by man and breeds in cities and agricultural areas. Although it is the dominant New Zealand dixid its larval populations are seldom large and only a few adults are found resting in the shade on vegetation surrounding the breeding sites.

DISTRIBUTION (fig. 28). Material examined: 2708 specimens; 131♂, 179♀, 8 adults, 2051 larvae, 339 pupae; 221 individual rearings (138 larval, 69 pupal, 14 incomplete).

NEW ZEALAND: *North Auckland*: Mangamuka Gorge, 2 mi N of Soda Spring, 21 Dec 1963, BS (NZ 41), 5 lp♀ (41-103, 104, 106, 108, 109), 1 p♂ (41-101), 1 lp (41-105), 46 L [UCLA]; same data (NZ 42), 2 lp♂ (42-101, 104), 2 lp♀ (41-103, 105), 1 p♂ (41-102), 23 L [UCLA]; S slope at bridge, 18 Feb 1965, F (NZ 206), 1 lp♂ (206-131), 5 L [UCLA]. Ruakaka, 20 Dec 1963, BS (NZ 36), 1 L [UCLA]. Wellsford, elev. 100 m, 31 May 1964, D. Forsyth (NZ 188), 3 L [UCLA]; first bridge S of city, 16 Feb 1965, F (NZ 204), 6 L [UCLA]. Dome Valley, 2 Jan 1965, F (NZ 198B), 1 ♀ [UCLA]; bridge S of Wellsford, 18 Feb 1965, F (NZ 208), 5 L [UCLA]. Albany, Rosedale Road, elev. 100 m, 18 May 1964, F (NZ 182), 1 lp♀ (182-124), 7 L [UCLA]. Bethells Road Swamp, 10 Jan 1965, F (NZ 200B), 1 p♂ (200B-103), 1 p♀ (200B-104), 1♂, 1♀, 2 L [UCLA]. 12 Jan 1965, F (NZ 202), 1 ♂, 2 L [UCLA]. Bethells Road, near quarry, 11 Apr 1964, F (NZ 179), 1 lp♂ (179-104). Waitakere Ranges, edge of Cascade Park, 18 Dec 1963, BS (NZ 35), 7 lp♀ (35-101, 112-117), 6 p♂ (35-102, 104-106, 109, 111), 4 p♀ (35-103, 107, 108, 110), 1 ♂, 1 ♀, 82 L, 6 P [UCLA]; same general locality, 28 Dec 1963, BS (NZ 58), 1 p♂ (58-101), 30 L, 1 P [UCLA]; Waitakere stream, 20 Feb 1964, F (NZ 177), 1 ♂ [UCLA]; same locality, date and collector (NZ 178), 1 p♂ (178-101) [UCLA]; Bethells Road at Cascades turnoff, elev. 20 m, 15 Nov 1964, F (NZ 195A & B), 1 ♂ (A), 10 L (B) [UCLA]; West Coast Road, first stream W of Scenic Drive, 8 Jan 1964, BS (NZ 81), 1 lp♂ (81-101), 2 lp♀ (81-102, 103), 14 L [UCLA]; West Coast Road, stream east of inlet to Nihotupu reservoir, 14 Jan 1964, S (NZ 98), 6 L [UCLA]. Swanson, Train Valley stream, elev. 166 m, 9 May 1964, F (NZ 183), 3 lp♂ (183-134, 135, 138), 2 lp♀ (183-136, 137), 12 L [UCLA]. Henderson, Opanuku stream, elev. 65 m, 26 Apr 1964, F (NZ 181), 1 lp♂ (181-125), 9 lp♀ (181-122, 124, 126-132), 1 lp (181-123), 2 ♂, 23 L, 1 P [UCLA]. Oratia, DSIR Field Station, 22 Dec 1963, BS (NZ 45), 3 L [UCLA]; 30 Dec 1963, S (NZ 66), 2 lp♀ (66-101, 102), 6 L, 3 P [UCLA]. Titirangi Beach, creek above dam, 30 Dec 1963, BS (NZ 64), 2 lp♀ (64-101, 104), 2 ♂, 1 ♀, 33 L [UCLA]; 11 Jan 1964, BS (NZ 94), 1 lp♂ (94-107), 1 lp♀ (94-101), 1 p♀ (94-103), 1 lp (94-106), 3 ♂, 116 L, 8 P [UCLA]; Mahoe Road, elev. 2 m, 4 July 1964, F (NZ 193), 2 lp♀ (193-121, 122), 9 L [UCLA]; same locality, elev. 5 m, 29 Nov 1964, F (NZ 195C), 1 ♂, 1 ♀ [UCLA]. Titirangi, French Bay, elev. 50 m, 14 June 1964, F (NZ 189B), 1 L [UCLA]; elev. 5 m, 4 July 1964, F (NZ 192B), 6 L [UCLA]. Avondale, elev. 60 m, 23 Nov 1964, F (NZ 216B), 1 p♀ (216B-101) [UCLA].

Little Barrier Island: Stream between Te Waikohare and Tirikikawa, elev. 7 m, 9 Oct 1963, S (NZ 11), 1 lp♀ (11-111), 1 lp (11-112) [UCLA]. Waipawa stream, 75-100 ft from mouth, 6 Mar 1964, S (NZ 130), 5 L [UCLA]. Tirikikawa stream, elev. 30 m, 8 Mar 1964, S (NZ 131), 2 lp♂ (131-101, 103), 1 lp♀ (131-104), 1 p♂ (131-102), 16 L [UCLA]. Hut Bay creek, near sea level, 8 Mar 1964, S (NZ 134), 1 p♂ (134-101), 4 L [UCLA].

Great Barrier Island: Port Fitzroy, 12 Mar 1964, S (NZ 138), 3 p♂ (138-102, 108, 109), 1 p♀ (138-110), 95 L [UCLA].

South Auckland: Te Aroha, 10 mi S, 5 June 1965, F (NZ 211), 3 L [UCLA]. Rotorua, Kuirau Hot Springs Reserve, 23 and 27 Dec 1963, BS (NZ 46), 1 lp♂ (46-140) [UCLA].

Gisborne: Ormond, Waihirere Domain, 25-26 Dec 1963, BS (NZ 48), 1 lp♂ (48-104), 5 lp♀ (48-101, 106, 107, 110, 112), 3 p♂ (48-102, 111, 113), 1 lp (48-108), 81 L, 1 P [UCLA]; 28 Mar 1964, S (NZ 140), 1 p♀ (140-103), 1 ♂, 8 L, 4 P [UCLA]. Hexton, at bridge H20, S16-41, 26 Dec 1963, BS (NZ 50), 1 lp♀ (50-111), 3 L, 1 P [UCLA]. Urewera National Park, Orangihikoa stream, elev. 2450 ft, 30 Mar 1964, S (NZ 141), 2 lp♀ (141-101, 104), 1 p♂ (141-102), 4 L [UCLA]; Mokau Falls, 27 Dec 1963, BS (NZ 55), 1 L [UCLA]; Aniwaniwa Falls, 27 Dec 1963, BS (NZ 52), 6 lp♀ (52-101-104, 106, 107), 3 ♂, 1 ♀, 78 L, 6 P [UCLA]. Terapatiki, 27 Dec 1963, BS (NZ 51), 1 p♂ (51-101), 1 L [UCLA].

Wellington: Mapiu, 7 June 1965, F (NZ 214), 1 L [UCLA]. Between Piriaka and Taumarunui, 7 June 1965, F (NZ 213), 1 p♂ (213-102), 10 L [UCLA]. Piriaka, elev. 200 m, 5 Jan 1965, F (NZ 199), 1 lp♀ (199-103), 1 p♀ (199-105), 9 L [UCLA]; 28 Mar 1965, F (NZ 210), 1 ♂ [UCLA]. Pokaka, 10 Jan 1964, BFS (NZ 87), 10 lp♀ (87-101, 108-113, 115-117), 5 p♂ (87-103-107), 2 lp (87-102, 114), 7 ♂, 7 ♀, 87 L, 14 P [UCLA]; old road junction, 10 Jan 1964, BFS (NZ 86), 3 lp♂ (86-102-105), 1 lp♀ (86-106), 17 L [UCLA]. Ohakune, Mountain Road, 9 Jan 1964, BFS (NZ 83), 4 lp♂ (83-106, 109, 110, 115), 10 lp♀ (83-103-105, 107, 108, 111-114, 116), 1 p♂ (83-125), 128 L, 18 P [UCLA]; 26 Jan 1964, F (NZ 175), 4 L [UCLA]; Rangataua Reserve Lake, 9 Jan 1964, BFS (NZ 84), 1 L [UCLA]; pond at bend of Lake Road, 9-10 Jan 1964, BFS (NZ 85B), 17 L [UCLA]. Ohakune, Sept 1922, T. R. Harris, 1 ♀ [BMNH], 10 Nov 1922, T. R. Harris, 1 ♀ [BMNH], 15 Dec 1922-15 Jan 1923, T.R. Harris, 1 ♀ [BMNH].

Nelson: Riwaka River, North branch, Crystal Pool, 4 Jan 1964, BF (NZ 74), 1 lp♂ (74-105), 7 lp♀ (74-101-104, 106-108), 4 ♂, 8 ♀, 21 L, 22 P [UCLA]; Riwaka River valley, north branch, 4 Jan 1964, BG (NZ 75), 1 ♂, 1 ♀, 8 L, 1 P [UCLA]. The Glen, 12 Mar 1964, S (NZ 168), 1 lp♀ (168-102), 4 p♂ (168-105, 106, 108, 109), 1 p♀ (168-107), 32 L [UCLA]. Wakapuaka, Glen Road, 12 Mar 1964, S (NZ 167), 1 lp♂ (167-101), 8 L [UCLA]. Todd's Valley, 12 Mar 1964, S (NZ 166), 1 lp♂ (166-101), 59 L [UCLA]. Dodson's Valley, 12 Mar 1964, S (NZ 165), 34 L [UCLA]. Blick's Valley, 12 Mar 1964, S (NZ 164), 55 L [UCLA]. Nelson Reservoir, 12 Mar 1964, S (NZ 163), 7 L [UCLA]. Nelson, N Branch Maitai River, elev. ca 400 ft, 11 Feb 1964, S (NZ 123), 1 ♂ [UCLA]; junction Maitai River and Sclanders stream, 11 Feb 1964, S (NZ 125), 1 lp♀ (125-102), 2 p♂ (125-103, 105), 2 p♀ (125-101, 106), 1 lp (125-104), 73 L, 3 P [UCLA]; South Branch Maitai River, 11 Feb 1964, S (NZ 127), 5 L [UCLA]; Maitai River, near Pole Ford, 14 Mar 1964, S (NZ 170), 24 L [UCLA]; Maitai River and Dod's Creek, 14 Mar 1964, S (NZ 171), 34 L [UCLA]; Cawthron Park, elev. ca 450 ft, 11 Feb 1964, S (NZ 124), 36 L [UCLA]; near DSIR, 3 Jan 1964, BG (NZ 73A, B), 1 lp♂ (73-108), 6 lp♀ (73-101-104, 107, 109), 2 lp (73-105, 106), 15 ♂, 13 ♀, 112 L, 19 P [UCLA]. Nelson, 10 Aug 1922, A. L. Tonnoir, 1 ♂ paratype [NELS], 5 Sept 1922, A. L. Tonnoir, ♂ holotype, 1 A paratype [NELS], 20 Sept 1923, A. L. Tonnoir, 1 A paratype [NELS], 1 ♂ paratype (I-299) [CANT], 28 Sept 1923, A. L. Tonnoir, 1 ♂ paratype [BMNH], 7 Dec

1921, A. L. Tonnoir, 1 ♂ paratype (I·301) [CANT]. Ngawhatu Mental Hospital, 11 Mar 1964, S (NZ 159), 1 lp♂ (159-101), 3 L [UCLA]. Annesbrook, elev. ca 20 m, 10 Mar 1964, S (NZ 158), 6 lp♀ (158-102-104, 106-108), 1 p♂ (158-105), 57 L, 3 P [UCLA]. Brightwater, 11 Mar 1964, S (NZ 161), 1 lp♂ (161-101), 2 L [UCLA]. Aniseed Valley, 5 Jan 1964, BG (NZ 79), 9 L, 1 P [UCLA]; same locality and date (NZ 80), 2 lp♀ (80-101, 105), 20 L [UCLA]. Lake Rotoiti, 9 Feb 1964, S (NZ 117), 1 p♂ (117-108), 12 L [UCLA]. Howard Junction, 1 mi E, 13 Mar 1964, S (NZ 169), 4 L [UCLA]. Gowanbridge, 9 Feb 1964, S (NZ 122), 12 L [UCLA]. New Creek Road, between Murchison and Kawatiri Junction, 8 Feb 1964, S (NZ 116), 2 lp♀ (116-102, 103), 2 p♂ (116-104, 105), 1 p♀ (116-101), 1 lp (116-107), 36 L [UCLA]. Reefton, Jan, A. L. Tonnoir, A [Tonnoir 1924b]. Springs Junction, elev. ca 560 m, 9 Mar 1964, S (NZ 156), 9 L [UCLA].

Marlborough: Kaikoura, 23 Feb 1922, A. L. Tonnoir, 1 A [NELS].

Westland: Lake Brunner [as Moana], 16-21 Dec 1922, A. L. Tonnoir, 2 ♀ [CANT]. Hercules Mt vicinity, 7 Feb 1964, S (NZ 115), 1 lp♀ (115-102), 1 p♀ (115-110), 15 L [UCLA]. Whataroa, 7 Feb 1964, S (NZ 114), 1 ♂ (114-108), 7 L [UCLA]. Waiho, A. L. Tonnoir, 17 Jan 1922, 1 ♂ paratype (I·304) [CANT], 19 Jan 1922, 1A paratype [NELS]; 30 Jan 1922, 4 A paratypes [NELS], 1 ♂ paratype (I·298), 1 ♀ paratype (I·302) [CANT]. Bridge Flat-Haast Road, 18 Dec 1966, N (NZ 224), 7 L [UCLA].

Canterbury: Christchurch, 13 July 1924, J. W. Campbell, 1 ♂ [CANT]. Governors Bay, 3 Jan 1964, BD (NZ 72), 2 lp♂ (72-104, 107), 1 lp♀ (72-106), 2 p♂ (72-101, 108), 31 L [UCLA]. Purau Creek, 20 Feb 1922, A. L. Tonnoir, 1 ♀ paratype (I·303) [CANT]; Purau Creek [as Christchurch--R. Purau], 22 Oct 1922, J. W. Campbell, 1 ♂ [BMNH].

Otago: Ben Lomond, Queenstown, 2 Feb 1964, S (NZ 111), 2 lp♀ (111-102, 105), 1 p♂ (111-104), 52 L, 2 P [UCLA]. Waianakarua River, 25 Jan 1964, S (NZ 102), 6 lp♀ (102-107, 109, 116, 118, 119, 124), 2 p♂ (102-105, 114), 11 p♀ (102-101-104, 106, 108, 110-113, 117), 3 lp (102-115, 121, 123), 53 L, 3 P [UCLA]. Dunedin, Botanical Gardens, 2 Jan 1964, BN (NZ 96), 1 L [UCLA]. Black Gully, 31 Jan 1964, S (NZ 109), 1 lp♀ (109-105), 1 L [UCLA]. Clinton, 9 mi N, 26 Jan 1964, S (NZ 103), 1 lp♂ (103-101), 1 lp♀ (103-103), 11 L [UCLA].

New Zealand, localities uncertain: Horseshoe Lake, 11 Nov 1924, collector unknown, 1 ♂ [USNM]. Locality and collector not specified, 28 Nov 1924, 1 ♀ [USNM].

8. *Paradixa tonnoiri* Belkin, n. sp.

Figs. 7, 11, 29

TYPES: *Holotype* ♂ (NZ 115-108) with associated pupal skin and genitalia slide, vicinity of Hercules Mt., 7-8 mi S of Harihari on route 6 (Westland), 7 Feb 1964, D. A. Schroeder [NELS]. *Allotype* ♀ (NZ 115-105) with associated larval and pupal skins, some data as above [NELS]. *Paratypes*: same data as the holotype, 1 ♂ (NZ 115-104) with associated pupal skin and genitalia slide, 1 ♀ (NZ 115-101) with associated larval and pupal skins, 40 L (NZ 115) [UCLA]; 2 L (NZ 115) [USNM]; 2 L (NZ 115) [BMNH]; 2 L (NZ 115) [NELS].

ADULTS. *Wing*: 2.5-2.7 mm. *Forefemur*: 1.2-1.3 mm. *Abdomen*: about 1.7 mm. Very similar to *neozelandica* as described by Belkin (1962:106-107), differing in the following diagnostic features. Wing without any distinct vein infuscations or any indication of a cloud on *r-m*. Mesonotum with light brown ground color and with a long anterior median stripe and a pair of long supraalar stripes of dark brown. Legs more uniformly dark. Haltere darkened on knob. Flagellar segments 1 and 2 as in *neozelandica*.

MALE GENITALIA (fig. 7). *Segment IX*: Moderately sclerotized. Tergite with rather distinct median caudal lobe bearing about 25-30 thin bristles, chiefly in distal part; lateral lobe inconspicuous, short and with about 3 thin bristles. Sternite with about 5, 6 heavier bristles on each side. *Sidepiece*: Short and broad; uniformly densely spiculate; no basal lobe; a prominent small elongate apical lobe bearing 5, 6 short apical and subapical bristles; dorsal surface with 3, 4 short thin bristles near base and 3 long thickened bristles near middle; lateral surface with 1 very long thickened subapical bristle; ventral surface with about 12, 13 long bristles. *Clasper* about as long as sidepiece; irregular in outline; with subbasal and submedian lobes each with 3-5 spiniforms; apex without spiniforms. *Phallosome*: Prosophallus similar to *fuscinervis* but its median process broader and less prominent. Aedeagal sclerite very narrow and capitate distally. Lateral sclerite of opisthophallus much smaller than in *neozelandica* and *fuscinervis* but strongly bulging laterally; proximal process not developed; distal process very large, very broad at base and with thumblike distal narrowed part with spiniform. *Proctiger*: Basal ventrolateral sclerotization very strong, bearing a short basal sternal elongate process with elongate slender apical spiniform, followed tergally by 2 recurved long spinelike processes each with a shorter heavier apical spiniform, and a short tergal cercal lobe bearing a slender apical bristle.

PUPA (fig. 11). *Abdomen*: 2.7 mm. *Trumpet*: 0.20 mm. *Paddle*: 0.65 mm. General morphology and chaetotaxy as figured; diagnostic characters as in the key; indistinguishable from *neozelandica* and *fuscinervis*. *Cephalothorax* uniformly moderately to lightly pigmented; tubercles apparently more numerous than in *neozelandica*; hairs lightly pigmented. *Trumpet* more or less barrel-shaped, not widened apically, quite variable in length; uniformly moderately pigmented, a little brighter than cephalothorax. *Abdomen* lightly to moderately pigmented, sometimes slightly darker laterally; tubercles indistinct except laterally; hairs lightly pigmented. *Paddle* uniformly moderately pigmented; serrations of internal and external margins variable; hair 1-P distad of level of middle of genital lobe.

LARVA (fig. 11). *Head*: 0.53 mm. *Posterolateral Lobe*: 0.33 mm. *Anal Segment*: 0.51 mm. General morphology and chaetotaxy as figured; diagnostic characters as in the key; very similar to *neozelandica* and *fuscinervis*, differing from the former chiefly in the following characters. Head capsule moderately pigmented. Antenna moderately to lightly pigmented, sometimes slightly darkened on apex, concolorous with or lighter than general surface of head capsule. Thoracic and abdominal spiculation similar to *neozelandica* except that spicules of thoracic dorsum are usually thinner, longer, lighter and much more dense, visible at 100X; dorsal intersegmental spicules longer and more hairlike. Hair 13-S usually distinctly shorter than posterolateral lobe of spiracular apparatus. Pecten plate lightly to moderately pigmented, distinctly differentiated from unsclerotized integument; hairlike spicules more distinct and usually present on entire plate; marginal pecten teeth similar to *neozelandica* but shorter and sometimes with additional spines, frequently heavily pigmented; submarginal spicules varied, frequently inconspicuous and in a single row; usually 1, 2 very small light basal postpecten spines; a broad, apically-fringed large apical postpecten spicule. Anal sclerotization usually lighter in color but darkened in the middle, length about 1.5-1.6 of posterolateral lobe; spiculation of saddle and caudal process more conspicuous; postanal spicules about twice as long as cylindrical process.

SYSTEMATICS. The adults of *tonnoiri* are very similar to *neozelandica* and could be easily confused with specimens of the latter with faintly marked wings. The separation of these 2 species on external color characters of the adults may be very tenuous since all 4 known specimens of *tonnoiri* are teneral and their color pattern may not be fully developed. The male genitalia of *tonnoiri* are very characteristic and unique as in other species of New Zealand *Paradixa*, however they clearly belong to the same type as those of *neozelandica* and *fuscinervis* and not to the type of *harrisi*. One similarity is evident with *harrisi* in the development of basal tergal hairs suggesting an incipient basal lobe on the sidepiece. The phallosome and proctiger complexes of *tonnoiri* are the smallest and simplest of all New Zealand *Paradixa*. There is a considerable variation even in the only 2 known specimens in the number and distribution of spiniforms on the clasper and in the number of bristles in the incipient basal lobe of the sidepiece.

The larvae of *tonnoiri* resemble *neozelandica* in the color of the antennae and in the spiculation of the body but are more like *fuscinervis* in the specializations of the pecten. There is considerable variation in the development and pigmentation of the pecten teeth in the fair-sized sample of larvae of *tonnoiri* but no significant overlap with *fuscinervis* in the diagnostic characters. The 4 larvae from the Bridge Flat population (NZ 224) all have very dark pecten teeth but in all other features resemble closely the other populations in which dark pecten teeth are uncommon.

As indicated under *neozelandica*, *P. tonnoiri* is closely related to this species and to *fuscinervis*. The rather wide known distribution on South Island, the apparent rarity and the presence of considerable variation within and between the disjunct populations of *tonnoiri* are suggestive of a relict population structure in this species. *P. tonnoiri* also seems to be the least modified member of the *neozelandica* complex on the basis of the male genitalia and larval features. It appears, therefore, that *tonnoiri* represents the earliest development of the *neozelandica* lineage in New Zealand.

BIONOMICS. All 4 collections of immature stages of *tonnoiri* were made in partial shade in slow-moving or standing water with abundant vegetation in broad river valleys. In 3 of these collections *tonnoiri* was associated with both *neozelandica* and *fuscinervis* and with the latter only in the fourth collection. In only 1 collection (NZ 115) did it appear to be the dominant species.

DISTRIBUTION (fig. 29). Material examined: 88 specimens; 2 ♂, 2 ♀, 80 larvae, 4 pupae; 4 individual rearings (2 larval, 2 pupal).

NEW ZEALAND: *Nelson*: Howard Junction, 1 mi E, along Buller River, 13 Mar 1964, S (NZ 169), 7 L [UCLA].

Westland: vicinity of Hercules Mt., 7-8 mi S of Harihari on route 6, 7 Feb 1964, S (NZ 115), ♂ holotype, ♀ allotype, 2 L paratypes [NELS], 1 ♂, 1 ♀, 40 L paratypes [UCLA]; 2 L paratypes [USNM]; 2 L paratypes [BMNH]. Bridge Flat-Haast Rd (NZ S1), 18 Dec 1966, N (NZ 224), 4 L [UCLA].

Otago: Waianakarua River, near bridge of highway 1, 25 Jan 1964, S (NZ 102), 20 L [UCLA].

9. *Paradixa harrisi* (Tonnoir)

Figs. 7, 12, 29

1925. Dixa harrisi Tonnoir, 1925:311. TYPE: *Holotype ♂ with genitalia mount (I-296), Ohakune (Wellington), N. Z., Mar 1923, T. R. Harris [CANT].

Paradixa harrisi of Belkin (1962:108).
Dixa (Paradixa) harrisi of Edwards (1932:14); Taylor (1934:7); Nowell (1951: 235).
Dixa harrisi of Cooper and Rapp (1944:250); Miller (1950:45).

ADULTS (Tonnoir 1925:fig. 1; Belkin 1962:figs. 32, 34). Wing: 3.0 mm. Forefemur: 1.25 mm. Abdomen: about 2.0 mm. As described by Belkin (1962:108); extremely similar to neozelandica and differing from it chiefly in the darker coloration and wing markings. Wing marked as in neozelandica except that cloud on r-m very intense black instead of diffuse brown and much larger, invading apex of cell R, base of cells R_5 and R_3 and projecting into cell R_1. Head darker but clypeus light in distal half; flagellar segment 1 shorter, about 8, 9 times as long as wide and about 1.7 of length of segment 2. Thorax uniformly dark except for a lateral light area in upper part of pleuron and wing base; darker supraalar stripes sometimes evident; bristles weaker and lighter. Hindfemur whitish; hindtibia lighter in middle.

MALE GENITALIA (fig. 7; Tonnoir 1925:fig. 1). As figured here and as described by Belkin (1962:108), with the following corrections and diagnostic features. Sidepiece: Sternomesal margin produced as a large flat winglike lobe, the 2 lateral lobes narrowly connected across midline at base; a very short inconspicuous apical process with 2, 3 apical bristles; a barely indicated basal tergomesal lobe bearing 3 moderately long bristles (as in tonnoiri); 3, 4 long distal tergal bristles. Clasper with a distinct subbasal lobe bearing 3-5 moderately long blunt spiniforms; distal part of shaft with 2, 3 similar spiniforms at least 1 of which is apical. Phallosome: Markedly different from other New Zealand species. Prosophallus with a very long distal median flat process crenulate apically, enclosing a small ovoid unsclerotized area and extending between the 2 aedeagal sclerites. Aedeagal sclerite very narrow and poorly sclerotized. Lateral sclerite of opisthophallus narrow, slightly concave laterally; its external proximal angle produced as a blunt process; its mesal margin with a very large recurved long sharp spine (without apical spiniform), followed distally by a shorter, straighter, narrower process bearing an apical spiniform. Proctiger: Basolateral sclerotization strong, its mesal ventral margin produced into a long, branched process, the basal branch short, both branches spinelike and bearing each a heavy apical spiniform; dorsolateral sclerotization joined to basolateral and nearly meeting its mate middorsally, produced into a spinelike process with curved apical part bearing a distal heavy spiniform and 2 subapical cercal bristles.

PUPA (fig. 12). Abdomen: 2.8 mm. Trumpet: 0.21 mm. Paddle: 0.71 mm. General morphology and chaetotaxy as figured; diagnostic characters as in the key; readily separated from other New Zealand Paradixa. Cephalothorax uniformly moderately to lightly pigmented; tubercles largely restricted to dorsal surface; hairs lightly to moderately pigmented. Trumpet distinctly widened apically, not barrel-shaped, pinna very wide; uniformly moderately pigmented, somewhat brighter than cephalothorax. Abdomen lightly to very lightly pigmented, somewhat darker laterally; tubercles indistinct except laterally; hairs lightly pigmented. Paddle with distal part narrower than in other species; moderately to lightly pigmented; serrations of internal and external margins variable; apex frequently with more than 1 heavy tooth; hair 1-P at level of the base of genital lobe.

LARVA (fig. 12). *Head*: 0.43 mm. *Posterolateral Lobe*: 0.28 mm. *Anal Segment*: 0.28 mm. General morphology and chaetotaxy as figured; diagnostic characters as in the key; in general similar to *neozelandica*, *fuscinervis* and *tonnoiri* but differing markedly from them in the following features. *Head*: Uniformly moderately pigmented with darker areas as in *neozelandica*; hair pigmentation moderate; hair 11-C usually with 3, 4 forks. *Antenna* moderately pigmented, concolorous with or slightly darker than head capsule; basal curvature less distinct; hairlike spicules of ventral surface shorter and heavier. *Thorax* with spiculation essentially as in *neozelandica*; hairs somewhat lighter. *Abdomen*: Spiculation pattern essentially as in *neozelandica* but spicules much shorter and more numerous, becoming heavier and more widely-spaced on sides and dorsum of VI-VIII; dorsal intersegmental spicules conspicuous at 100X; proleg hooks and ambulacral spines as in *neozelandica* but smaller; hairs somewhat lighter. *Spiracular Apparatus*: Base (caudal part) of sclerite of anteromedian lobe with short heavy spinelike spicules; median area with separate large lateral and small median sclerites, lateral sclerites with numerous heavy spinelike spicules, median sclerite with only a few smaller spicules. Hair 13-S distinctly longer than posterolateral lobe. Pecten plate moderately pigmented; with scattered hairlike spicules in basal half; dorsal part of posterior margin with about 10 darkly pigmented simple teeth of moderate size, ventral part of posterior margin near apex with 3-7 very large heavy black spinelike teeth fused at base; proximad of these along posterior margin several separate smaller spinelike dark teeth or normal branched pecten teeth; 3 rows of submarginal broad apically-fringed large spicules; no basal postpecten spines or apical postpecten spicules; pecten hair 1-S with 9-15 dendritic branches. *Anal Segment*: Unsclerotized part of segments IX, X densely covered with very long hairlike spicules; sclerotized part very short, about equal in length to posterolateral lobe of spiracular apparatus, heavily pigmented; saddle with a submedian transverse patch of heavy slender spinelike spicules; caudal process with large number of similar but longer spicules ventrally and 1-3 laterally; postanal spicules almost half as long as cylindrical process.

SYSTEMATICS. Superficially, the adults of *harrisi* are very similar to *neozelandica* from which however they can be differentiated easily by the large saturated dark blotch on *r-m*, the darker coloration of the thorax and the light hindfemur. I am recognizing a separate group for *harrisi* because of striking characters in the male genitalia (especially the claspettelike lobe of the sidepiece and the prosophallus), the larva (spiracular apparatus, pecten and anal segment) and the pupa (flared trumpet and position of hair 1 on the paddle).

As in the case of *tonnoiri*, the rather wide known distribution, in this case on North Island, the apparent rarity, and the considerable intra- and interpopulation larval variation in *harrisi* suggest a relict population structure in this species. This similarity probably indicates that *tonnoiri* and *harrisi* were developed contemporaneously, possibly from the same stock. It is also possible that *harrisi* represents a completely different lineage which arrived in New Zealand contemporaneously with the *neozelandica* lineage. As indicated in the discussion of the systematics of *Paradixa*, I favor the first explanation.

BIONOMICS. All 10 collections of immature stages of *harrisi* came from the margins or isolated pools of small streams in narrow valleys always in partial to deep shade. The water was still or only slowly moving. The populations of *harrisi* were always very small except in 1 instance on Great Barrier Island (NZ 138) where this species was the dominant one in association with *neozelandica*, *fuscinervis* and *Nothodixa campbelli*. It was associated with *fuscinervis* on 4 other occasions and with both *fuscinervis* and *neozelandica* in 2 collections in both of which neozelandica was dominant. In 2 collections it was associated with *N. campbelli*; in 1 of these *neozelandica* and *fuscinervis* were also present.

Adults of *harrisi* were not encountered in the field during the present survey and Tonnoir did not record the circumstances of the capture of the type series by C. T. Harris.

DISTRIBUTION (fig. 29). Material examined: 155 specimens; 15 ♂, 16 ♀, 94 larvae, 30 pupae; 18 individual rearings (2 larval, 16 pupal).

NEW ZEALAND. *North Auckland*: Mangamuka Gorge, elev. ca 500 m, 18 Feb 1965, F (NZ 205), 1 L [UCLA]; S slope at bridge, 18 Feb 1965, F (NZ 206), 1 L [UCLA]. Brynderwyn Roadside, S slope, elev. ca 330 m, 18 Feb 1965, F (NZ 207), 1 p♀ (207-133), 1 p (207-131), 1 P (207-132) [UCLA]. Titirangi Beach, creek above dam, 11 Jan 1964, BS (NZ 94), 1 ♂, 3 L [UCLA]. Titirangi, French Beach, elev. 50 m, 14 June 1964, F (NZ 189B), 1 lp♂ (189B-131), 1 l [UCLA].

Little Barrier Island: Waipawa stream, 75-100 ft from mouth, 6 Mar 1964, S (NZ 130) 1 ♀. Tirikikawa stream, elev. 30 m, 8 Mar 1964, S (NZ 131), 1 p♀ (131-105). Hut Bay Creek, near sea level, 8 Mar 1964, S (NZ 134), 1 p♀ (134-102), 1 p, 7 L [UCLA].

Great Barrier Island: Port Fitzroy, 12 Mar 1964, S (NZ 138), 1 p♂ (138-101), 2 L [NELS]; 1 p♂ (138-104), 2 L [USNM]; 1 p♀ (138-106), 2 L [BMNH]; 2 p♂ (138-103, 114), 1 lp♀ (138-115), 5 p♀ (138-107, 111-113, 116), 2 ♂ (650525-33, 34), 7 P, 72 L [UCLA].

South Auckland: Te Aroha, 10 mi S, 5 June 1965, F (NZ 211), 2 ♀, 2 p, 1 L [UCLA].

Wellington: Ohakune, March 1923, T. R. Harris, ♂ holotype [CANT], 2 ♂, 2 ♀ [BMNH]; Nov 1923, T. R. Harris, 1 ♂ [BMNH]; Mountain Road, 9 Jan 1964, BFS (NZ 83), 1 p♂ (83-101), 1 p♀ (83-102) [UCLA].

SUBFAMILY CULICINAE

The True Mosquitoes

The Culicinae are readily recognized from the Dixinae and Chaoborinae in all stages by the characters given in the key to the subfamilies.

TERMINOLOGY. The descriptive terminology and abbreviations used by Belkin (1962: 547-561) for all stages is followed except for a few minor changes. On the head of the adults the *interocular space* is used here for the median space between the eyes below the vertex; the *frons* is now restricted to the area on the front of the head between the eyes and the antennae; *interorbital* bristles are substituted for frontal bristles; the *orbital* bristles are divided into the *upper orbitals* on the vertex and the *lower orbitals* on the sides. On the wing the point of branching of vein R into veins R_1 and Rs is designated as the *furcation of R*, the point of branching of vein Rs into veins R_{2+3} and R_{4+5} as the *furcation of Rs*, and so on for the furcation of R_{2+3}, M and Cu. In the male genitalia the term *opisthophallus* is introduced; it is explained in the discussion of the male genitalia of the Dixinae.

SYSTEMATICS AND BIOGEOGRAPHY. The details of the affinities and systematics of the New Zealand Culicinae are discussed under each tribe below. Only the general features of this fauna are reviewed here. The fauna is harmonious, relatively extensive, and largely endemic at the species group level.

Five of the 10 widespread tribes of the Culicinae recognized by Belkin (1962:117) are represented in New Zealand. Of the 7 tribes represented in the relatively well known fauna of Victoria, Australia (Dobrotworsky 1965), only the Anophelini and Aedeomyiini have not been found in New Zealand.

There are 2 endemic monotypic genera (*Opifex* in the Aedini and *Maorigoeldia* in the Sabethini) and 2 endemic monotypic subgenera (*Austromansonia* in *Coquillettidia*; and *Nothoskusea* in *Aedes*). The other subgenera represented by indigenous species in New Zealand are generally considered to be the primitive ones in their respective genera (the nominate subgenus *Culex* in the Culicini; *Climacura* in *Culiseta*; the nominate subgenus *Coquillettidia* in the Mansoniini; *Halaedes* and *Ochlerotatus* in *Aedes*).

Eleven of the 14 species are endemic to New Zealand. The ubiquitous tropical house mosquito, *Culex quinquefasciatus*, is undoubtedly introduced and the widespread *Aedes (Finlaya) notoscriptus* is also considered here to be a recent human introduction although the evidence supporting this is equivocal. The third non-endemic species, *Aedes (Halaedes) australis*, is considered here to have reached New Zealand by natural means and not human introduction.

Except in the Culicini, each endemic species group is represented in New Zealand by a single species and without any indication of geographical differentiation. In the *pervigilans* complex of *Culex*, 2 ecologically isolated species, *asteliae* in leaf axils and *rotoruae* in thermal waters, are recognized in addition to the widespread *pervigilans* which exhibits some geographical differentiation in its peripheral populations. There is a suggestion of hybridization between *pervigilans* and the introduced *quinquefasciatus*.

There is no indication of any affinity between the Culicinae of New Zealand and of South Chile-Patagonia. In general the affinities are primarily with the fauna of Southeast Australia-Tasmania; definitely so in case of *Opifex*, *Aedes (Nothoskusea)*, *Aedes (Halaedes)*, *Culiseta (Climacura)* and *Coquillettidia (C.)*, but not as clearly in case of *Coquillettidia (Austromansonia)*, *Aedes (Ochlerotatus)* and *Culex (C.)*. In most instances the New Zealand representatives appear to have retained more primitive features than their Australian-Tasmanian relatives and are considered to be the earliest derivatives of their respective phylads.

A very striking feature of the New Zealand Culicinae is the presence of bristles on the lower surface of the base of vein Sc not only in *Culiseta* but in *Coquillettidia (Austromansonia)*, *Opifex* and *Aedes (Nothoskusea)*, in the female only in the latter. This character appears to have been a primitive feature in the subfamily Culicinae. Equally striking is the presence of spicules on the outer surface of all the claws of the females (sometimes males also) in at least one member of each tribe represented in New Zealand. Similar spicules are found in all New Zealand Dixinae and I consider them to be a primitive feature in the Culicinae. The other apparent important primitive features retained in the Culicinae of New Zealand are: (1) in the adults, strong development of the scape of the antenna in *Opifex*, wide interorbital space on the head of *Opifex*, *Aedes (Nothoskusea)* and *Aedes (Halaedes)*, and strong development of bristles and poor development of scales on the head, thorax and abdomen in the same groups, (2) in the pupa of *Opifex* the similarity of hair 9-VII to hair 9 on preceding abdominal segments.

Contrary to the generally accepted view that short male palps and non-plumose antennae are derived characters, I suggest that the primitive state in the Culicinae is more likely to have been retained in the females and therefore postulate the following as the primitive condition in the subfamily: (1) antenna similar in the 2 sexes, with flagellar whorls poorly developed in both, (2) palpus similar in the 2 sexes, with its length varied in the different phyletic lines. Both of these features are retained in *Aedes (Nothoskusea)* and relatively little modified in *Opifex*.

The Culicinae do not offer unequivocal evidence for the number of waves of dispersal in their population of New Zealand. However, the situation in the *Opifex*-*Aedes (Nothoskusea)*-*Aedes (Halaedes)* complex suggests that at least 2 different dispersals, possibly 3, have occurred, the last one, involving *australis*, being much more recent.

KEYS TO TRIBES AND GENERA

Adults

1\. Spiracular bristles present 2
Spiracular bristles absent 3

2(1). Wing with conspicuous bristles on lower surface of base of vein Sc (Culisetini) . . . . *Culiseta*
Wing without bristles on lower surface of base of vein Sc (Sabethini; 23. *M. argyropus*). . . . . *Maorigoeldia*

3(1). Postspiracular bristles present (Aedini) 4
Postspiracular bristles absent 5

4(3). Scape of antenna strongly developed, visible as a distinct segment all around at base of torus . . . . *Opifex*
Scape of antenna a narrow ring, visible only at mesal articular point with torus . . . . *Aedes*

5(3). Claws with basal whitish ~~padlike~~ pulvillus (Culicini) . . . . *Culex*
Claws without basal whitish padlike pulvillus (Mansoniini) . *Coquillettidia*

Male Genitalia

1\. Paraproct of proctiger with conspicuous crown of numerous spicules (Culicini) . . . . *Culex*
Paraproct of proctiger with 1-6 spinelike teeth only 2

2(1). Distal part of clasper irregular, with a more or less distinct subapical lobe (Mansoniini) . . . . *Coquillettidia*
Distal part of clasper regular in shape, without any indication of a subapical lobe 3

3(2). Opisthophallic lobe strongly developed between the aedeagus and proctiger (Sabethini; 23. *M. argyropus*) . . . . *Maorigoeldia*
Opisthophallic lobe not differentiated 4

4(3). Apex of paraproct with 4 distinct teeth; mesal surface of sidepiece without membrane (Culisetini; 14. *C. tonnoiri*) . . . . *Culiseta*
Apex of paraproct with only 1 tooth, simple or with small denticles; mesal

surface of sidepiece with more or less distinct membrane (Aedini) . 5

5(4). Cercal setae of 2 types, short distally, long proximally; sidepiece without long bristles laterally and ventrally . . . . *Opifex*
Cercal setae all subequal and short; sidepiece with long bristles laterally and ventrally . . . . *Aedes*

Pupae

1. Trumpet without distinct pinna, apex specialized for piercing plant tissues (Mansoniini) . . . . *Coquillettidia*
Trumpet with distinct pinna. 2

2(1). Paddle with strongly produced apex and without apical hairs (Sabethini; 23. *M. argyropus*) . . . . *Maorigoeldia*
Paddle rounded or emarginate apically, with at least hair 1-P developed 3

3(2). Hair 9-VIII on ventral surface, removed cephalad from caudolateral margin (Culicini) . . . . *Culex*
Hair 9-VIII at posterolateral angle of segment 4

4(3). Paddle hair 2-P present in addition to 1-P but very small; hair 1-IX present, simple (Culisetini; 14. *C. tonnoiri*) . . . . *Culiseta*
Paddle hair 2-P not developed; hair 1-IX absent or irregular (Aedini) . 5

5(4). Hair 9-VII simple, short, similar to hairs 9-II-V in shape and position . . . . *Opifex*
Hair 9-VII dorsal in position and markedly different from hairs 9-II-V . . . . *Aedes*

Larvae

1. Median dorsal valve of siphon very long, fixed and with serrated inner dorsal margin adapted for piercing plant tissues (Mansoniini). . . . . *Coquillettidia*
Median dorsal valve of siphon short, movable and never with serrated inner dorsal margin. 2

2(1). Ventral brush of anal segment (4-X) with only 1 pair of hairs (Sabethini; 23. *M. argyropus*) . . . . *Maorigoeldia*
Ventral brush of anal segment (4-X) with 5 or more pairs of hairs . . 3

3(2). Siphon with only 1 pair of subventral tufts (1-S) (Aedini) 4
Siphon with several pairs of subventral tufts (1, 1a-S) 5

4(3). Metathoracic pleural group (9-12-T) very small, longest hairs less than 0.5 of long hairs in mesothoracic pleural group . . . . *Opifex*
Metathoracic pleural group (9-12-T) at most moderately reduced, longest hair more than 0.5 of long hairs in mesothoracic pleural group . . . . *Aedes*

5(3). Siphon with a very small hair tuft (1-S) at the very base (Culisetini; 14.

C. tonnoiri) . . . . *Culiseta*
Siphon without such a differentiated hair at extreme base (Culicini) . . . . *Culex*

TRIBE CULICINI

Genus CULEX

1758. *Culex* Linnaeus, 1758:602. TYPE SPECIES: *Culex pipiens* Linnaeus, 1758, Europe, selection of Latreille (1810:442).
For complete synonymy see Stone, Knight and Starcke (1959).

The species of *Culex* known to occur in New Zealand are readily recognized from other Culicinae by the following combinations of characters. In the females, the tarsi are dark, the hindtibia has a conspicuous apical light spot, the labium is light-scaled on the lower surface to the apical fourth, and the abdomen has basal light transverse bands on the tergites. In the males, the tarsi, hindtibia and abdomen are the same as in the females, and the lower surface of the palpus has a line of white scales on segment 4 and a basal spot of similar scales on segment 5. In the pupae, hair 9 on segment VIII is located on the ventral surface a considerable distance cephalad of the posterolateral angle. The siphon of the larvae is distinctive in the presence of several subventral tufts none of which is placed at the extreme base *and* the ventral brush is strongly developed. A general account of the genus and tribe is given by Belkin (1962: 177-180).

SYSTEMATICS AND BIOGEOGRAPHY. The genus *Culex* is represented in New Zealand by the introduced *quinquefasciatus* of the notorious *pipiens* complex and 3 species of the endemic *pervigilans* complex. The two complexes belong to the *pipiens* group (Belkin 1962, not Edwards 1932, 1941) of the subgenus *Culex* and are very similar in all stages but particularly in general external adult characters, pupae and even male genitalia. There is a suggestion of introgressive hybridization of *quinquefasciatus* and *pervigilans* in New Zealand.

C. quinquefasciatus has probably been introduced several times to New Zealand on ships from the earliest days of sailing vessels to recent times. It appears to be established only in the northern part of North Island (fig. 33) and even here it is not very successful in competing with *pervigilans* and other native species, judging by our survey. While we found it breeding only in a few large artificial containers and never in ground waters, Graham (1939:211) reported it to breed "through the year in any place exposed to full sunlight and holding water charged with decaying organic matter." Environmental conditions do not seem to be particularly favorable for *quinquefasciatus* in New Zealand, and this may be one of the reasons for its apparent hybridization with the native *pervigilans*. However, during favorable periods *quinquefasciatus* may become more abundant as reported by Graham.

Mattingly and Rageau (1958:241) placed *pervigilans* in their *trifilatus* subgroup which included also *iyengari* Mattingly and Rageau, 1958 from New Caledonia, *pacificus* Edwards, 1916 from New Hebrides and Banks Islands, *miraculosus* Bonne-Wepster, 1937 from New Guinea, the Palaearctic *torrentium* Martini, 1925 and *vagans* Wiedemann, 1828, and the Ethiopian *trifilatus* Edwards, 1914 and *tamsi* Edwards, 1934 (Belkin 1962:fig. 84). In comparing the pattern of distribution of the *trifilatus* subgroup to those of some species groups of *Neoculex*, *Ochlerotatus* and *Culiseta*, Mattingly and Rageau made no comment on the absence of this subgroup from Australia, where all the other groups are represented. I suggest that the reason for this absence is that the *trifilatus* subgroup is not really distinct from the *pipiens* complex and that the lineage of the *pervigilans* complex, *iyengari* and *pacificus* is represented by 3 native species in Australia, *globocoxitus* Dobrotworsky, 1953 and two forms currently regarded as subspecies of *pipiens*, *australicus* Dobrotworsky and Drummond, 1953 and the "*molestus*" of these authors which is not *molestus*, Forskal, 1775. I believe that the situation in Australia is probably analogous with that in New Zealand in that introgressive hybridization may have occurred between the introduced *quinquefasciatus* and the native *australicus* but that this has proceeded farther with the formation of "*molestus*" of Dobrotworsky and Drummond (1953:132).

Edwards' tentative synonymy of *torrentium* with *pervigilans* (1932:210) lead to the view that *pervigilans* may be nothing more than the European *torrentium* introduced during the extensive whaling operations in the nineteenth century (see Mattingly and Rageau). Now that 3 distinct species are known in the *pervigilans* complex in New Zealand this view should be discarded for it is most unlikely that *asteliae* and *rotoruae* were formed in the recent past from an introduced species.

Speciation in the *pervigilans* complex has taken place without distinct differentiation in the male genitalia but with strong differentiation in the larva. Two of the species are ecologically isolated, *rotoruae* in thermal waters, *asteliae* in the leaf axils of terrestrial and epiphytic astelias. The dominant *pervigilans* is a general ground water breeder which invades large artificial containers, where it comes in contact with *quinquefasciatus*. *C. pervigilans* has a very wide distribution with isolated populations on the Kermadec, Chatham and Auckland islands. None of the isolated populations, with the exception of a small one in Ocean Island in the Auckland group, is strikingly marked, and all show a great deal of individual variation as do the populations on the main islands of New Zealand. It seems probable that there has been considerable dispersal and intermixing of *pervigilans* populations through human transport and that this species is clearly not prone to the formation of reproductively isolated geographical populations.

Keys to Species

Females

1. Abdominal sternites II-VII with light scales only . . 13. *quinquefasciatus*
Abdominal sternites II-VII with extensive dark scaling in the middle and on posterolateral areas 2

2(1). Mesonotal scaling predominantly dark bronzy, fossa with numerous short curved bronzy scales and without light scales. . . 11. *rotoruae*
Mesonotal scaling predominantly light coppery, golden or whitish, fossa with light scales and at most with a few dark scales 3

3(2). A conspicuous patch of curved bronzy scales between supraalar and posterior dorsocentral bristles in front of level of wing . . .12. *asteliae*

Scales on this patch usually light golden, not conspicuously differentiated from other scales (not reliable) . . . . 10. pervigilans

Males

1. Dark scales of sternites II-VII confined to median area . . . . 13. quinquefasciatus

Dark scales of sternites II-VII more extensive, present on posterolateral areas as well as in the middle 2

2(1). Palpal segment 3 with no more than 10 long bristles in a single outer row in the distal half . . . . .12. asteliae

Palpal segment 3 with at least 25 long bristles in a double outer row in the distal two-thirds 3

3(2). Mesonotal scales predominantly bronzy on disc, with contrasting whitish scales in lateral, supraalar and prescutellar areas . 11. rotoruae

Mesonotal scales predominantly light golden on disc, not markedly darker than elsewhere. . . . . 10. pervigilans

Male Genitalia

1. Basal sternal process of proctiger very short, weak and poorly pigmented; tergal arm of outer division of phallosome short and straight, barely projecting beyond distal margin of inner division. . . . . .13. quinquefasciatus

Basal sternal process of proctiger long, strong, curved and heavily pigmented; tergal arm of outer division of phallosome very long, angled distally and projecting well beyond distal margin of inner division . . . . 10. pervigilans; 11. rotoruae; 12. asteliae

Pupae

1. Pinna of trumpet strongly oblique, its maximum dimension at least 0.4 of total trumpet length. . . . . .13. quinquefasciatus

Pinna more transverse, its maximum dimension less than 0.33 of total trumpet length 2

2(1). Trumpet slender, index at least 8.0; hair 5-IV about 1.5 of length of tergite V. . . . . .12. asteliae

Trumpet moderately broad, index less than 6.0; hair 5-IV shorter, usually less than 1.25 of length of tergite V. . . . . .10. pervigilans; 11. rotoruae

Larvae

1. Ventral brush with 7 pairs of hairs; siphon usually with 5 pairs of tufts all below level of pecten and more or less in line. . . . 11. rotoruae

Ventral brush with 6 pairs of hairs; siphon usually with 4 pairs of tufts, 1 or 2 pairs out of line above level of pecten 2

2(1). Two pairs of siphonal tufts clearly above level of pecten; prothoracic hairs 7, 8-P both single; saddle hair 1-X usually double . .12. asteliae

Usually only one pair of siphonal tufts above level of pecten (out of line) or all hairs more or less in line; prothoracic hairs 7, 8-P usually both double; saddle hair 1-X usually single 3

3(2). Hair 1 on abdominal segments III-V usually at least 4-branched; mental plate usually with less than 9 teeth on each side of apical tooth; subapical siphonal tuft usually only slightly out of line; siphon relatively long, index usually more than 5.0 . . . . 10. pervigilans

Hair 1 on abdominal segments III-V usually single or double; mental plate usually with at least 10 teeth on each side of apical tooth; subapical siphonal tuft usually conspicuously out of line; siphon relatively short, index usually less than 5.0. . . . . . . 13. quinquefasciatus

10. Culex (C.) pervigilans Bergroth

Figs. 14, 30, 31

1889. Culex pervigilans Bergroth 1889:295. TYPE: Holotype ♀, Greymouth, Westland, New Zealand [Location unknown].

Culex (C.) pervigilans of Edwards (1924:396; 1932:209); Graham (1929:216-227; 1939:211); Taylor (1934:24); Lee (1944:109); Miller (1950:44); Miller and Phillipps (1952:19); Mattingly and Rageau (1958:241); Stone, Knight and Starke (1959); Dumbleton (1962:24, 25; 1965:142-143); Belkin (1962:190-191); Nye and McGregor (1965:4-7).

Culex (C.) sp. 3, Auckland Island form of Belkin (1962:191).

Culex sp. of Harrison (1956:211).

FEMALE (Graham 1929:figs. 25-32; Miller and Phillipps 1952:figs. 32-34). Wing: 4.5 mm. Proboscis: 2.1 mm. Abdomen: about 3.0 mm. In general similar to members of the pipiens complex from which it is distinguished in New Zealand by presence of dark scales in posterolateral areas and middle of abdominal sternites and other characters mentioned under quinquefasciatus. Extremely variable in most features and very similar to other members of pervigilans complex from which it cannot be always separated. General coloration of integument very dark, usually blackish brown on mesonotum and head; mesonotal scales largely elongate and straight, usually pale and contrasting sharply with mesonotal integument. Head: Decumbent scales whitish, creamy to golden; erect scales similar in color to decumbent in the middle and in front, a variable patch of darker scales posterolaterally, these sometimes blackish. Labium conspicuously pale-scaled ventrally usually to apical 0.25, sometimes pale-scaled dorsally near middle. Palpus usually with whitish, creamy or golden scales on segments 3 and 4; these scales sometimes very conspicuous. Flagellar segment 1 usually with distinct patch of pale scales as on palpus. Thorax: Mesonotal scales usually predominantly whitish, creamy or golden, sometimes a more or less conspicuous supraalar patch of shorter, more curved, light bronzy scales. Apn and ppn scales as on mesonotum; psp usually without hairs or scales; stp and mep scales usually pure white, rarely creamy or golden (Auckland Is. populations). Legs: Femora usually predominantly dark-scaled on anterior surface, rarely hindfemur indistinctly paler on anterior surface ventrally, ventral and posterior light scaling restricted; knee spots and apical hindtibial spot usually large and conspicuous, usually whitish; lower surface of tibiae and basal tarsal segments not distinctly pale; midcoxa, hindcoxa and extreme base of all femora with light scales; remainder of legs dark-scaled. Claws all without teeth and all with short fine spicules on outer surface of base. *Haltere*: Upper part of stem and all of knob with pale brown scales. *Abdomen*: Tergite I with small median apical patch of dark scales, rarely with a few light scales; tergites II-VII with basal transverse light bands which are lengthened caudad at lateral ends progressively more from III to VII, median part straight or widened in the middle particularly on III, IV, V, light scaling usually whitish; sternites with varied amount of dark scaling but always with at least posterolateral angles and basal median areas dark-scaled on distal segments, pale scaling usually whitish.

MALE (Graham 1929:fig. 34). Essentially as in the female. Palpus exceeding proboscis by at least full length of segment 5, sometimes more; segment 4 with white-scaled line ventrally from base to apex, segment 5 with small basal ventral patch of white scales, segment 3 with lighter scales dorsolaterally; segment 3 usually with at least 25 very long external ventral hairs in a double row in the distal half to two-thirds; segments 4 and 5 with dense vestiture of very long ventrolateral hairs on both sides. Labium without ventral pale streak, entirely dark except for very inconspicuous lighter area around false joint.

MALE GENITALIA (fig. 14; Graham 1929:fig. 33; Nye and McGregor 1964: figs. 3a, b). As figured here and as described by Belkin (1962:190); apparently indistinguishable from other members of the complex. Subapical lobe of sidepiece with 1-3 setae in group *d-f* not 1 as stated by Belkin (loc. cit.). Inner division of phallosome short, bent as in *pipiens* complex; lateral arm of outer division strongly developed, in dorsal aspect appearing angled and bearing fine spicules internally; tergal arms very long, in dorsal aspect divergent, angled mesad distally and extending at least to level of apex of proctiger. Basal sternal process of proctiger very long, sharply curved ventrad and strongly pigmented.

PUPA (Belkin 1962:fig. 90; Graham 1929:figs. 48, 49). *Abdomen*: 3.7 mm. *Trumpet*: 0.75 mm. *Paddle*: 1.05 mm. As figured and described by Belkin (1962:190); very similar to *quinquefasciatus* and *asteliae*, and indistinguishable from *rotoruae*. Trumpet relatively short and broad, index usually less than 6.0; pinna usually less than 0.25 of trumpet length; usually darkened at base and apex and lighter in the middle. Hair 5-IV usually shorter than tergite V. Both paddle hairs usually present.

LARVA (Belkin 1962:fig. 91; Graham 1929:figs. 37-47; Lee 1944:plate 82; Miller and Phillipps 1952:fig. 36; Nye and McGregor 1964:fig. 4a). *Head*: 0.92 mm. *Siphon*: 1.55 mm. *Saddle*: 0.46 mm. As figured and described by Belkin (1962:190); in general similar to *asteliae*, *rotoruae* and *quinquefasciatus*; extremely variable but readily distinguished from the above by the diagnostic characters in the key and the following features. Head capsule uniformly moderately to strongly pigmented; mental plate with 6-8 coarse teeth on each side of median apical tooth; aulaeum very conspicuous and projecting. Antenna long and very slender, usually at least 0.7 of head length; usually uniformly darkly pigmented; spicules strong, usually extending distad of hair 1. Prothoracic hairs 4, 7 and 8 usually all double, rarely triple. Abdominal hair 1-III-V usually 3, 4b; hair 6-III-VI usually double or triple. Siphon usually uniformly moderately or darkly pigmented, sometimes darkened at base and apex; extremely variable in length but index usually about 5.5-7.0; usually 4 subventral tufts (1, 1a-S), subapical slightly to distinctly out of line, proximal usually distad of pecten, all longer than width of siphon but very variable in length and number of branches. Saddle usually moderately to strongly pigmented, spiculation usually inconspicuous; hair 1 usually single. Ventral brush usually with 6 pairs of hairs. Anal gills subequal; variable in length, usually distinctly longer than saddle.

SYSTEMATICS. As interpreted here, *C. pervigilans* is readily separated from the other 2 members of its complex, *rotoruae* and *asteliae*, in the larval stage by features of the siphon and anal segment, from *asteliae* in the pupal stage by the shape of the trumpet and from *rotoruae* in the adults by the mesonotal scaling. Its pupa is apparently indistinguishable from *rotoruae* and the adults cannot be separated with certainty from *asteliae*. The male genitalia appear to be very similar in all 3 species, but with more detailed study it may be possible to separate *asteliae* from the other 2 species of the *pervigilans* complex.

C. pervigilans is the dominant, commonest and most widespread culicid of the New Zealand region. It exhibits a great deal of variation in nearly all features of all stages even in the diagnostic ones, although in the latter there is no overlap with either *rotoruae* or *asteliae*. There appears to be nearly as much intrapopulation as interpopulation variation in most characters, suggesting that considerable hybridization between originally isolated populations is occurring at the present and probably has been going on for some time. As indicated under *quinquefasciatus* there is a suggestion of introgression of some *pervigilans* features in the populations near Auckland, and it is possible that some introgression of *quinquefasciatus* features has occurred in *pervigilans* populations in other areas.

There is considerable geographical differentiation in *pervigilans* in the isolated insular populations. It is very likely that considerable mixing in these populations has occurred as a result of transport of breeding populations from place to place on sailing vessels and motor ships since early in the last century. It is, of course, possible also that some of these insular populations were originally established through such human agency. In none of the remote insular populations is there differentiation in the larval stage approaching that found in the ecologically separated species of the complex on the main islands of New Zealand, even at the two extremes, Kermadec and Auckland islands, where environmental conditions must be very different.

The Kermadec population appears to be quite different from the other remote insular populations but unfortunately the material is very limited. There are only 5 fourth-instar larvae in the single larval collection. These have a general facies quite distinct from the New Zealand populations. The pigmentation of the head capsule, antenna, all hairs, siphon and anal saddle is much lighter; the hairs are generally weaker; the anal gills are distinctly shorter than the anal saddle; hair 6-III-V is usually triple, and prothoracic hairs 3, 7, 8-P are sometimes triple; the teeth of the mental plate are 6 or 7; the siphon is long and slender and without marked tapering distad, its index is about 6.0-7.0; the position of the siphonal tufts (1, 1a-S) tends to be irregular, the basal one is sometimes with the pecten and the preapical one tends to be strongly displaced dorsad. There is considerable variation in nearly all these features and all the variations encountered are frequently found in the populations from the main islands of New Zealand but not in exactly the same combination in a single population. The mesonotal scaling of the adults tends to be more yellowish and the mesonotal bristles shorter than in the typical main New Zealand populations. The male genitalia show no unusual characters; there is only 1 seta in group *d-f* and 8-10 bristles on the lobe of tergite IX. I see no reason for considering this as anything but a small isolated population of *pervigilans* adapted to subtropical insular conditions.

The Chatham Islands population is the most isolated of all pervigilans populations, this island group being about 500 miles from Cape Pallister at the southeast end of North Island. In the adequate sample of larvae there is more variation than is usually found in individual New Zealand collections, as would be expected in smaller isolated insular populations, but all of the features of the Chatham population fall within the range of variation of pervigilans on the main islands. The general facies of these larvae is quite different from that of the Kermadec population and appears more similar to that of the Auckland Islands populations but is not markedly different from the main island populations although it is more or less distinct. The pigmentation of the sclerotized parts and hairs is moderate to strong; the larger hairs have strong branches; the anal gills are usually only slightly longer than the anal saddle; the antenna tends to be shorter than in New Zealand, the siphon is shorter (index 5.0-5.5); the proximal siphonal tuft (1-S) tends to be within the pecten and the 2 distal tufts usually have more branches; prothoracic hairs 4, 7, 8-P are frequently triple as is abdominal hair 6-III-V. Except for 2 males the few reared adults are in alcohol and it is not possible to determine accurately the color of the mesonotal scales. The male genitalia are essentially similar to those of the main island populations; there are 1 or 2 setae in group d-f and 6-12 bristles on the lobe of tergite IX. In the male, segment 3 of the palpus has an indistinct line of pale scales dorsolaterally above the long external bristles and the labium an indistinct pale ring around the false joint. In my opinion, the Chatham Islands population is not sufficiently differentiated to be recognized as a separate taxonomic entity.

The Auckland Islands populations are of considerable interest because they are found near the southern known limit of occurrence of the family. The larvae in the 3 collections are quite similar and are not markedly different from the Chatham Island population except that they usually have more branches in abdominal hair 6-III-V (5-7), prothoracic hairs 4, 7, 8-P are more frequently triple and may have even 4 or 5 branches, and the siphon is a little longer. As in the other isolated insular populations there is a great deal of individual variation in larval characters. The sample of adults is very small but very interesting because of apparent striking differences between the Ranui population on the main Auckland Island and the population on the adjacent very small Ocean Island. The Ranui adults are of normal size and coloration and the lobe of tergite IX bears 6-9 bristles. The Ocean Island adults are the largest I have seen (wing length of female, 6 mm), the light scaling of the head and thorax is distinctly yellowish and the lobe of tergite IX of the male genitalia bears 16-18 bristles. Males of both populations have a distinct line of whitish scales in the middle of segment 3 of the palpus above the long external bristles; Ranui males have an indistinct narrow pale ring around the false joint of the labium and in the Ocean Island males this light ring is much larger and more conspicuous; one male from Ranui has 2 setae in group d-f, all the others have only one. In females of both populations the light ventral scaling of the labium extends dorsad to form an indefinite broad pale ring which is larger and more conspicuous in the Ocean Island population. If any population of pervigilans deserves recognition as a separate taxonomic entity, it is the Ocean Island one. However, before this is done, more material is needed to evaluate the puzzling situation of the presence of 2 apparently distinct populations in the Auckland Islands. Several possibilities exist to account for these different populations including the presence of an indigenous form and the introduction of one or more populations at different times in the past.

I have made no attempt to analyze critically the populations of pervigilans from the main islands of New Zealand and the adjacent small islands. This would require a special study with more material than I have available. However, a superficial examination reveals a great deal of variation in all stages without any clear indication of geographical differentiation. In the larva particularly, there is bewildering variation in nearly all features: in the length and pigmentation of the antenna; in the pigmentation of the head capsule and the branching of head hairs; in the branching and character of the larger thoracic and abdominal hairs; in the length and shape of the siphon, the number of pecten teeth, and the branching, distribution and character of the siphonal tufts; and in the length of the anal gills. However, there is no significant overlap in any of the characters which are diagnostic of rotoruae and asteliae in the larval stage; the antenna is never as short as in rotoruae and the ventral brush never has 7 pairs of hairs as in this species; the siphon is never as long as in asteliae and never has the characteristic arrangement and branching of the siphonal tufts of this species. In the pupa, the pinna of the trumpet is extremely variable and sometimes approaches the condition in quinquefasciatus. In the adults, the mesonotal and head scaling also show a great deal of variation, some of which is probably due to the partially teneral condition of the reared specimens. In the male genitalia the most conspicuous variation is found in the number of setae in group d-f (1-3) and the number of bristles on the lobe of tergite IX (6-13); in the case of the latter, however, the number seems to be relatively constant within a given population.

BIONOMICS. C. pervigilans is the dominant and most widespread culicid of the New Zealand area, probably because of its wide tolerance of environmental conditions as shown by its very wide range of breeding sites. It has been reported by Graham (1929:221, 226) to breed in all types of ground waters, still and with moderate flow, clean and contaminated, fresh and with as much as 75 % sea water, and from a multitude of small and large artificial containers. In our field work we found pervigilans most commonly in natural breeding sites (stream margins, springs, pools, ponds and swamps) and in ditches and drains, and much less frequently in various types of artificial containers (concrete cisterns, metal tanks, drums and pans). This species has been found associated with all other culicids breeding in artificial containers and ground waters except O. fuscus and A. chathamicus. Breeding continues throughout the year at least around Auckland (Graham 1929:226).

C. pervigilans is apparently a serious nocturnal domestic pest in some years both in cities and rural areas (Graham 1929:219) but does not seem to attack man readily out of doors or in the field. All of our adult collections were made in buildings. The natural hosts of pervigilans are probably birds. Ross, Austin et al (1963) have isolated viral agents from pervigilans.

DISTRIBUTION (figs. 30, 31). Most widely distributed culicid of the New Zealand area from Kermadec Islands to Auckland Islands and Chatham Islands. Material examined: 4180 specimens; 327 ♂, 364 ♀, 2805 larvae, 684 pupae; 170 individual rearings (82 larval, 66 pupal, 22 incomplete).

KERMADEC ISLANDS. Raoul Island: Station cistern, 28 Sept 1962, G. A. Samuelson (89), 63 L [BISH]. Bell's Ravine, elev. 75 m, Malaise trap, G. A. Samuelson, 7-12 Sept 1962, 1 ♀, 13-14 Sept 1962, 17 ♀ [BISH]. N Slope Ridge, elev. 150 m, light trap, 6-11 Oct 1962, G. A. Samuelson, 1 ♂ [BISH]. Locality not specified, 9 Oct 1908, 3 ♂ [CANT]; Aug 1908, 1 ♂, [WELL].

NEW ZEALAND. North Auckland: Waipapakauri, 26 June 1944, G. L.

Bissett (371), 1 L [NELS]. Awanui, 16 Feb 1944, W. J. Phillipps (43), 1 L [NELS]. Whangaroa, 1 ♀ [WELL]. Kaeo, 3 mi S on route 10, 20 Dec 1963, 1963, BS (NZ 39), 1 lp♂ (39-101), 10 L [UCLA]. Mangamuka Gorge, 2 mi N of Soda Spring, 21 Dec 1963, BS (NZ 41), 71 L [UCLA]. Ngawha, 16 Feb 1944, W. J. Phillipps (46), 3 L [NELS]. Opua, 3 mi S of turnoff on Kawakawa-Paihia road, 20 Dec 1963, BS (NZ 38), 2 L [UCLA]. Waipoua forest, 19 Mar 1945, W. J. Phillipps (642), 3 L [NELS]. Whangarei, 8 Jan 1919, D. Miller, 3 ♂ [BMNH]; 10 Jan 1919, D. Miller, 1 ♂, 2 ♀ [BMNH]. Ruakaka, 1 mi S on highway 1, 20 Dec 1963, BS (NZ 36), 4 lp♂ (36-101, 106, 108, 109), 1 lp♀ (36-110), 1 p♂ (36-102), 3 p♀ (36-103-105), 2 lp (36-107, 112), 1 ♂, 2 ♀, 111 L, 12 P [UCLA]. Hen Is (Taranga), 1925, 1 ♂ [WELL]. Wellsford, elev. 100 m, 31 May 1964, F (NZ 188), 4 L [UCLA]. Martins Bay, Mahurangi Heads, 26 Dec 1964, F (NZ 196), 1 L [UCLA]. Parakai, 18 July 1918, D. Miller, 1 ♂, 2 ♀ [BMNH]. Hobsonville, 25 Oct 1944, G. L. Bissett (419), 1 L [NELS]. Bethells Road Swamp, 9 May 1964, F (NZ 184), 1 L [UCLA]; 10 Jan 1965, F (NZ 200B), 1 L, 2 P [UCLA]; 12 Jan 1965, F (NZ 202), 1 L [UCLA]. Waitakere Ranges, Quarry tributary of Waitakere River, 18 Dec 1963, BS (NZ 35), 4 L [UCLA]; 0.25 mi S from main turnoff to Karekare from Piha Road, 14 Jan 1964, S (NZ 97), 70 L, 1 P [UCLA]; 2 Nov 1944, G. L. Bissett (442), 1 ♂, 1 ♀ [NELS]. Oratia, DSIR Field Station, 22 Dec 1963, BS (NZ 45), 7 L [UCLA]; 30 Dec 1963, S (NZ 66), 7 L [UCLA]. Titirangi Beach, 30 Dec 1963, BF (NZ 64), 1 L [UCLA]. Titirangi, 9 Jan 1946, G. L. Bissett (831), 3 L [NELS]; 18 Mar 1946, G. L. Bissett (891), 1 ♀ [NELS]; swamp in field near forest, 1 July 1946, G. L. Bissett (975), 1 L [NELS]. Takapuna, 1943, W. J. Phillipps, 1 ♂ [WELL]. Devonport, Shoal Bay, 18 Jan 1917, D. Miller, 1 ♂ [BMNH]. Northcote, Clarence Road, 30 Sept 1963, S (NZ 9), 1 ♂, 33 L, 4 P [UCLA]. Auckland, Arch Hill, catch basin, 3rd Ave, 26 Mar 1919, D. Miller, 1 ♂, 1 ♀ [BMNH]; Avondale, 23 Nov 1965, F (NZ 216B), 1 ♀ [UCLA]; Cabbage Tree Swamp, 26 Mar 1919, D. Miller, 1 ♀ [BMNH]; Ellerslie, gully swamp, race course, 24 Mar 1919, D. Miller, 1 ♂, 1 ♀ [BMNH]; Kaitaria Swamp, 2 Feb 1917, D. Miller, 1 ♂ [BMNH]; Kohimarama, 29 Apr 1946, G. L. Bissett (926), 2 L [NELS]; Mt. Albert, 1916-1925, A. E. Brooks, 7 ♂, 3 ♀ [BMNH]; Mt. Wellington, 14 June 1945, G. L. Bissett (736), 2 ♂, 1 ♀ [NELS]; Newton, 22 Feb 1944, Francis, 3 ♂, 11 ♀ [WELL]; Owairaka, 2 July 1946, G. L. Bissett (976), 2 ♂, 2 ♀ [NELS]; Penrose, 18 May 1944, G. L. Bissett (328), 1 L [NELS], 15 July 1946, G.L. Bissett (990), 4 L [NELS]; Three Kings, 11 July 1946, G. L. Bissett (982), 6 L [NELS]; Westmere, 17 Nov 1944, G. L. Bissett (464), 1 L [NELS], 11 Jan 1946, G. L. Bissett (836), 2 L [NELS]. Auckland, locality unspecified, 27 July 1923, O. H. Swezey, 1 ♀ [BISH]; 18 Dec 1941, T. R. Rabone, 1 ♂, 1 ♀ [AUCK]; ex spring, 20 Jan 1950, K. Wise, 1 ♀ [AUCK]. Mangere, 7 Jan 1965, F (NZ 201), 1 ♀, 1 P [UCLA]; 26 Oct 1950, K. Wise, 1 ♀ [AUCK]; Oct 1950, K. Wise, 1 ♀ [AUCK]. Howick, 24 May 1917, A. E. Brookes, 1 ♂, 2 ♀ [BMNH]. Hunua Range, 1 Jan 1916, A. E. Brookes, 1 ♀ [BMNH]. Pukehoke, sewage oxidation plant, 25 May 1964, F (NZ 186), 1 lp♀ (186-112), 1 p♀ (186-111) [UCLA]. Tuakau, 9 June 1964, F (NZ 190), 1 lp♂ (190-121) [UCLA].

Little Barrier Island: Near Ranger's house, 9 Oct 1963, S (NZ 10), 16 L [UCLA]. Near Ranger's chicken house, 6 Mar 1964, S (NZ 129), 1 lp♂ (129-104), 1 lp♀ (129-103), 3 p♂ (129-102, 109, 112), 7 p♀ (129-108, 110, 111, 113-117), 5 ♂, 14 ♀, 38 L, 41 P [UCLA]. Small stream between Te Waikohare and Tirikikawa streams, 9 Oct 1963, S (NZ 11), 3 lp♂ (11-102, 106, 107), 4 lp♀ (11-101, 103-105), 2 lp (11-108, 110), 3 ♂, 38 L, 3 P [UCLA]; 6 Mar 1964, S (NZ 128), 1 p♂ (128-118), 3 p♀ (138-101, 102, 115), 41 ♂, 14 ♀, 112 L, 80 P

[UCLA]. Summit Track, elev. 267 m, 9 Oct 1963, S (NZ 12), 1 L [UCLA]. Between Lamb Bay creek and Awaroa stream, 31 Oct 1963, S (NZ 20), 4 ♂, 5 ♀, 19 L, 8 P [UCLA]. Awaroa stream, 0.5 mi upstream, 31 Oct 1963, S (NZ 22A, B), 3 ♂, 10 L, 5 P [UCLA]; 0.25 mi upstream, 31 Oct 1963, S (NZ 23A, B), 6 ♂, 3 ♀, 24 L, 10 P [UCLA]. Waipawa stream, 6 Mar 1964, S (NZ 130), 3 lp♀ (130-112-114), 1 p♂ (130-109), 6 p♀ (130-110, 111, 115-118), 17 ♂, 15 ♀, 73 L, 45 P [UCLA]. Tirikikawa stream, 8 Mar 1964, S (NZ 131), 1 L [UCLA].

Great Barrier Island: Shoal Bay, 25 Oct 1963, S (NZ 16), 1 lp♂ (16-105), 14 L [UCLA]. Te Wairere stream, 26 Oct 1963, S (NZ 17), 3 L, 1 P [UCLA]. Locality not specified, 16 Feb 1919, D. Miller, 1 ♂ [BMNH].

Cuvier Island: 13 Mar 1963, S (NZ 136), 1 L [UCLA].

South Auckland: Coromandel, 25 Apr 1964, N (NZ 220), 19 L [UCLA]. Te Puke, Prew Orchard, 31 Mar 1964, S (NZ 142), 5 L [UCLA]. Karapiro, 25 Jan 1946, A.W. Jamison (852), 3 ♂, 3 ♀ [NELS]. Te Kuiti, 18 Dec 1944, G. Milne (500), 1 ♂, 1 ♀; 30 Jan 1946, J. Beattie (853), 2 ♂, 1 ♀ [NELS].

Gisborne: Waioeka Gorge, 19 Nov 1963, S (NZ 29), 1 ♀, 18 L, 2 P [UCLA]. Ormond, 17 Nov 1963, S (NZ 28), 4 ♂, 3 ♀, 18 L, 7 P [UCLA]; Waihirere Domain, 28 Mar 1964, S (NZ 140), 3 L [UCLA]. Hexton, 26 Dec 1963, BS (NZ 50), 3 lp♀ (50-101-103), 2 p♂ (50-106, 110), 5 p♀ (50-104, 105, 107-109), 1 ♀, 25 L, 9 P [UCLA]. Mokau Falls, Urewera National Park, 27 Dec 1963, BS (NZ 55), 2 lp♂ (55-101, 102), 1 lp (50-103), 2 ♂, 1 ♀, 54 L, 9 P [UCLA]. Lake Waikaremoana, 27 Jan 1957, E.N. Marks (9, 10), 2 ♂, 1 ♀, 4 L [UCLA].

Hawke's Bay: Cape Kidnappers, 16 Nov 1963, S (NZ 27), 5 lp♂ (27-101, 104, 106, 109, 110), 2 lp♀ (50-102, 107), 3 lp (50-103, 105, 108), 1 ♀, 14 L, 4 P [UCLA].

Wellington: Tokaanu, Dec 1943, W.J. Phillipps, 2 ♀ [WELL]. Pokaka, 10 Jan 1964, BFS (NZ 86), 1 lp♂ (86-101), 1 lp♀ (86-107), 1 p♂ (86-104), 14 L [UCLA]. Ohakune, Rangataua Reserve lake, 9 Jan 1964, BFS (NZ 84), 168 L [UCLA]; pond at bend of Lake road, 9, 10 Jan 1964, BFS (NZ 85), 1 L [UCLA], 26 Jan 1964, F (NZ 174), 4 L, 5 P [UCLA], 28 Jan 1964, F (NZ 176), 3 ♀ [UCLA]; locality not specified, 1 ♀, July-Aug 1922, T.R. Harris [BMNH], 1-9 Apr 1923, T.R. Harris, 1 ♂ [BMNH]. Kaitawa, Nov 1922, 1A [WELL]. Otaki, 30 Dec 1943, W.J. Phillipps (184), 4 L, 1 P [NELS]. Masterton, 10 Jan 1945, F. Ellett (515), 2 ♂, 2 ♀ [NELS]. Kapiti Island, 1 Oct 1928, 1 ♀ [WELL]. Paraparaumu, 1944, W.J. Phillipps, 3 ♂, 3 ♀ [WELL]. Lower Hutt, 15 Nov 1945, W.J. Phillipps (827), 3 ♂ [NELS]. Featherston, 18 Jan 1945, F. Ellett (510), 1 ♀ [NELS]. Castle Pt., Wairarapa, 7 Dec 1945, F. Ellett and W.J. Phillipps (829), 5 L, 2 P [NELS]. Wellington, 24 Apr 1924, 1 ♀ [WELL], 6 Jan 1929, J.T. Salmon, 2 ♂ [WELL], 29 Nov 1943, 1 ♂ [WELL], 4 Jan 1944, W.J. Phillipps, 1 ♂, 2 ♀ [WELL], 22 Feb 1944, W.J. Phillipps, 3 ♂, 4 ♀ [WELL]; Kelburn, 29 Feb 1944, W.J. Phillipps, 5 ♀ [WELL]; Ohariu Valley, 7 Feb 1944, W.J. Phillipps (16a), 1 L [NELS]; Rocky Bay, 14 Dec 1943, 1 ♂ [WELL]; Wilton Bush, Feb 1922, G.V. Hudson, 1 ♀ [BMNH]; Wilton Road, Jan 1944, 2 ♂, 1 ♀ [WELL].

Nelson: Canaan Beech Forest, Harwood's Hole, 4 Jan 1964, BG (NZ 77), 1 ♂, 22 L, 1 P [UCLA]; Harwood's Hole track pond, 4 Jan 1964, BG (NZ 78), 1 lp♂ (78-101), 9 lp♀ (78-102-110), 12 ♂, 7 ♀, 105 L, 21 P [UCLA]. North Branch Riwaka River, 4 Jan 1964, BG (NZ 75), 3 L [UCLA]. Wakapuaka, 12 Mar 1964, S (NZ 167), 1 L [UCLA]. Nelson, 3 Jan 1964, BG (NZ 73), 8 ♂, 4 ♀, 29 L, 11 P [UCLA], 16 Mar 1923, A.L. Tonnoir, 2 ♂, 1 ♀ [NELS], 1 L (696) [NELS]; Cawthron Institute, 24 Jan 1945, W.J. Phillipps (548), 1 L [NELS]; Blick's Valley, 12 Mar 1964, S (NZ 164), 2 L, 1 P [UCLA]; Maitai River, junction of Sclanders stream, 11 Feb 1964, S (NZ 125), 3 L [UCLA], south Branch, 11 Feb 1964, S (NZ 126), 32 P [UCLA], near Pole Ford Bridge, 14 Mar 1964, S (NZ 170), 8 L, 2 P [UCLA]; North Road, 16 Nov 1943, 1 ♀ [WELL]; Reservoir, 12 Mar 1964, S (NZ 163), 2 lp♀ (163-101, 102), 2 ♂, 126 L, 44 P [UCLA]; Tahunanui, 10 Mar 1964, S (NZ 157), 3 ♂, 50 L, 8 P [UCLA]. Stoke, 11 Mar 1964, S (NZ 160), 13 L, 12 P [UCLA]. Aniseed Valley, 21 Mar 1922, A. L. Tonnoir, 1 ♀ [NELS]. Poorman's Valley, 30 Nov 1944, E. S. Gourlay (472), 1 A [NELS]. Wairoa Valley, 23 Jan 1945, B. B. Given (546), 2 L [NELS]. Howard Junction, 13 Mar 1964, S (NZ 169), 22 L, 3 P [UCLA]. Kawatiri Junction, 9 Feb 1964, S (NZ 120), 1 lp♀ (120-106), 2 p♂ (120-101, 102), 1 p♀ (120-104), 2 lp (120-105, 107), 16 ♂, 5 ♀, 68 L, 46 P [UCLA]. New Creek Road, between Murchison and Kawatiri Junction, 8 Feb 1964, S (NZ 116), 46 L [UCLA]. Gowanbridge, 9 Feb 1964, S (NZ 122), 12 L [UCLA]. Gowan River, 9 Feb 1964, S (NZ 121), 1 p♂ (121-103), 10 L [UCLA]. Lake Rotoroa, 21 May 1923, C. L. Edwards, 1 ♀ [BMNH].

Marlborough: Blenheim, 18 Oct 1945, W. J. Phillipps (823), 19 L, 1 P [NELS]. Kaikoura, Feb 1922, A. L. Tonnoir, 1 ♂ [NELS].

Westland: Greymouth, date and collector not specified, holotype ♀ [Bergroth 1889:295, location unknown]. Hercules Mountain, 7 Feb 1964, S (NZ 115), 11 L [UCLA]. Whataroa, 7 Feb 1964, S (NZ 114), 1 p♂ (114-102), 3 p♀ (114-103, 106, 107), 13 L [UCLA]. Waiho, 7 Feb 1964, S (NZ 113), 38 L [UCLA]. Localities not specified, A [J. S. Pillai 1966:25].

Canterbury: Kaiapoi, 28 Aug 1963, S (NZ 3B), 3 ♀ [UCLA], 21 Jan 1964, S (NZ 99), 1 ♂, 3 ♀ [UCLA]. New Brighton, Nov 1943, S. Lindsay, 1 ♂, 3 ♀ [WELL]. Christchurch, F. W. Hutton (90), 1 ♂, 8 ♀ [BMNH], 21 July 1899, R. L. Scott, 3 ♂, 4 ♀ [BMNH], 17, 18 Feb 1922, A. L. Tonnoir, 1 ♂, 1 ♀ [NELS]. Akaroa, Dec 1945, D. Miller (830), 10 L [NELS]. Timaru, 24 Jan 1964, S (NZ 100), 1 lp♂ (100-107), 2 lp♀ (100-102, 109), 2 p♂ (100-108, 112), 3 p♀ (100-106, 111, 113), 1 lp (100-105), 271 L, 22 P [UCLA]. Makikihi, 25 Jan 1964, S (NZ 101), 29 L [UCLA].

Otago: Kinloch, 11 Jan 1957, E. N. Marks (21, 22), 1 ♂, 1 ♀ [UCLA]. Frankton, L [Nye and McGregor 1964:7]. Middlemarch, L [Nye and McGregor 1964:7]. Dunedin, Leith Valley, 1 Aug 1922, G. Howes, 1 ♀ [BMNH]; Otago Museum grounds, L [Nye and McGregor 1964:7]. Otago Peninsula, Hooper's Inlet, 2 Jan 1964, BN (NZ 71), 1 lp♀ (71-101), 1 lp (71-102), 2 ♂, 1 ♀, 76 L, 3 P [UCLA]; Allan's Beach, Doctor's Point, Hooper's Inlet, L [Nye and McGregor 1964:7]. Taeri Plain, L [Nye and McGregor 1964:7]. Catlins District, 19 Jan 1957, E. N. Marks (26), 1 ♂, 1 ♀, 4 L, 2 P [UCLA], L [Nye and McGregor 1964:7].

Southland: Te Anau, 2 Feb 1964, S (NZ 110), 1 lp♀ (110-104), 1 p♂ (110-102), 1 p♀ (110-101), 1 lp (110-103), 29 L, 4 P [UCLA]. Between Invercargill and Bluff, 28 Jan 1964, S (NZ 107, 108), 1 lp♂ (107-101), 2 lp♀ (107-103, 104), 1 p♂ (107-105), 1 p♀ (107-102), 1 ♂, 1 ♀, 27 L, 9 P (107), 53 L, 1 P (108) [UCLA]. Bluff, 26 Jan 1964, S (NZ 104), 2 lp♂ (104-113, 183), 2 lp♀ (104-111, 112), 2 p♂ (104-182, 184), 1 p♀ (104-181) [UCLA].

Stewart Island: Oban, road to Observation Rock, 27 Jan 1964, S (NZ 105), 2 lp♂ (105-104, 111), 4 lp♀ (105-105-107, 110), 5 p♂ (105-102, 108, 109, 112, 113), 1 p♀ (105-101), 2 lp (105-103, 114), 50 ♂, 30 ♀, 66 L, 123 P [UCLA]. Golden Bay, 27 Jan 1964, S (NZ 106), 1 lp♂ (106-108), 4 lp♀ (106-102, 104, 106, 107), 1 p♂ (106-101), 1 p♀ (106-103), 10 L [UCLA].

New Zealand, locality unspecified or unknown: Locality not specified, 15-22 July 1923, T. R. Harris, 1 ♂ [BMNH]; 1 ♀ [WELL]; 1957, E. N. Marks (1, 2), 6 L, 1 P [UCLA]; 1921, D. Miller, 1 ♂ [UCLA]; 2 L (345), 2 ♀ (488), 2 ♀ (506), 1 ♀ (507), 13 L (617), 3 ♂, 3 ♀ (901), 1 ♂, 2 ♀ (917) [NELS]. Waituhi(?) forest, 26 Mar 1945, W. J. Phillipps (636), 2 L [NELS]. Tutara, Urewera, 26 Mar 1945, W. J. Phillipps (661), 1 L [NELS].

CHATHAM ISLANDS. Flying boat base, 26 Feb 1964, S (NZ 151), 2 lp♂ (151-103, 104), 1 lp♀ (151-106), 1 lp (151-105), 11 L [UCLA]. Owenga, 26 Feb 1964, S (NZ 152), 3 lp♂ (152-101, 102, 107), 2 lp♀ (152-105, 106), 2 lp (152-103, 104), 98 L [UCLA]. Waitangi, 29 Feb 1964, S (NZ 154), 3 p♀ (154-101-103), 5 ♂, 21 ♀, 29 L, 30 P [UCLA]. Waitangi West, 28 Feb 1964, S (NZ 153), 145 L, 1 P [UCLA]. Locality not specified, Nov 1959, L. J. Dumbleton, 2 ♂, 1 ♀, 15 L, 2 P [Dumbleton].

AUCKLAND ISLANDS. Tucker Point, 20 Jan 1963, L. J. Dumbleton, 2 L, 1 P, egg raft. Ranui, 28 Dec 1962-22 Jan 1963, L. J. Dumbleton, 5 ♂, 2 ♀, 31 L, 10 P. Ocean Island, 23-29 Dec 1962, L. J. Dumbleton, 1 lp♂ (L2), 3 lp♀ (L1, 3, 4), 1 p♀ (PA), 3 lp (L5-7), 2 p, 2 ♀ (14a), 4 p, 2 ♂, 2 ♀ (14b), 5 L, 1 P (14), 3 ♂, 2 ♀, 4 L, 8 P [Dumbleton].

11. Culex (C.) rotoruae Belkin, n. sp.

Figs. 13, 32

Culex (C.) sp. 2, Rotorua form of Belkin (1962:191).

TYPES: Holotype ♂ (NZ 46-111) with associated larval and pupal skins and genitalia slide, Kuirau Hot Springs Reserve, Rotorua (South Auckland), New Zealand, 23-27 Dec 1963, J. N. Belkin and D. A. Schroeder [NELS]. Allotype ♀ (NZ 46-102) with associated larval and pupal skins, same data as holotype [NELS]. Paratypes: 26 ♂, 35 ♀, 1251 larvae, 81 pupae (NZ 46), same data as holotype, as follows: 1 lp♀ (46-103), 1 ♂ (640124-1), 5 L [CANT]; 5 L [NELS]; 1 lp♀ (46-108), 1 ♂ (640124-2), 5 L [USNM]; 1 lp♀ (46-110), 1 ♂ (640124-3), 5 L [BMNH]; 2 lp♀ (46-117, 119), 14 lp (46-101, 104-107, 109, 112-116, 118, 120, 121), 23 ♂, 30 ♀, 1226 L, 76 P [UCLA].

FEMALE. Wing: 3.75 mm. Proboscis: 1.75 mm. Forefemur: 1.6 mm. Abdomen: about 2.6 mm. In general very similar to pervigilans as described above but distinguished from it by the following features. Size considerably smaller and general coloration darker. Erect scales of head predominantly dark, from light brown to black; palpus with very few or no white scales; first flagellar segment with only a few light scales. Mesonotal integument darker; mesonotal scaling predominantly dark bronzy not contrasting with integument; fossa with numerous short curved bronzy scales and without light scales; light scaling restricted to narrow inconspicuous lines on anterior promontory, lateral prescutal, posterior fossal, supraalar and lateral prescutellar areas; scutellum with light scales as in pervigilans. Pleuron very dark brown; apn and ppn scales less numerous and darker; ppl, stp, mep scales whitish but less numerous. Tergal abdominal bands narrower, straighter; sternites predominantly dark-scaled, whitish scales largely restricted to basolateral patches.

MALE. Distinguished from pervigilans by the same characters of thoracic ornamentation as the female and the following. Palpus essentially as in pervigilans but with long hairs more numerous. Abdomen apparently with more numerous and longer ventral hairs; tergites with larger basal transverse light markings. Hindfemur with more distinct light line on anterior surface.

MALE GENITALIA (fig. 13). As figured, apparently indistinguishable from *pervigilans*. Leaf of subapical lobe perhaps smaller; 1 or 2 setae in group *d-f*.

PUPA (fig. 13). *Abdomen*: 2.94 mm. *Trumpet*: 0.6 mm. *Paddle*: 0.85 mm. As figured, apparently indistinguishable from *pervigilans*. Trumpet relatively short and broad, index usually about 6.0; pinna usually about 0.25 of trumpet length; uniformly dark or lighter in middle. Hair 5-IV usually shorter than tergite V. Both paddle hairs usually present.

LARVA (Belkin 1962:fig. 92). *Head*: 0.84 mm. *Siphon*: 1.26 mm. *Saddle*: 0.39 mm. As figured by Belkin (1962), in general similar to *pervigilans* and resembling *quinquefasciatus* in the short antenna; distinguished from the former by the following features. Posterior part of head capsule strongly darkened; hairs 5-7-C shorter and with more branches; mental plate usually with 5, 6 teeth on each side. Antenna short and straight, usually less than 0.5 of head length; uniformly darkly pigmented. Prothoracic hairs 4, 7, 8-P frequently triple. Abdominal hair 1-III-V weaker; 6-II usually 4, 5b; 6-III-VI usually triple. Comb scales shorter. Siphon lightly pigmented, base and apex darkened; index about 4.0; pecten spines usually with only 2, 3 anterior teeth; subventral tufts (1, 1a-S) usually 5 pairs (rarely 4, 6, 7) all in line on ventral part of siphon, basal 1, 2 pairs within the pecten, proximal ones usually with about 10 branches which are subequal to width of siphon or shorter. Ventral brush usually with 7 pairs of hairs, very rarely with 13 hairs; hair 2-X often triple. Anal gills short, pointed, usually subequal to saddle length or shorter.

SYSTEMATICS. *C. rotoruae* is most readily differentiated from the other members of the *pervigilans* complex by the characteristic development of the siphon and ventral brush of the larva but it can also be recognized relatively easily by the dark mesonotal scaling of the adults. There is remarkably little variation in these diagnostic characters as well as in most other features of the larva except for the length of the antenna. There is no significant overlap in either the adult or the larva with *pervigilans* or *asteliae*. On the other hand, the pupa appears to be indistinguishable from *pervigilans* and the male genitalia show no obvious differences from either *pervigilans* or *asteliae*.

C. rotoruae is known at present only from Rotorua and immediate vicinity near the center of the volcanic district which apparently dates from early Pleistocene. However, the derivation of *rotoruae* from the *pervigilans* stock may have taken place during one of the earlier periods of volcanic activity. It would be of great interest to determine the entire present range of *rotoruae* and any areas of overlap or contact with *pervigilans*.

BIONOMICS. We found immature stages of *rotoruae* in very large numbers in thermal pools and their outflows with a water temperature ranging from 80° to 83°F (NZ 46). Wallwork collected larvae in a "stagnant pool with a temperature of 80°F" (504) and in "clear water, temperature 100°F" (503). This species may breed in cooler water also, since Forsyth found at least one larva in the stream bounding the Whakarewarewa thermal area in water of "normal temperature, not thermal" (NZ 185). No other mosquitoes are definitely known to utilize the same breeding sites as *rotoruae*; the single rearing of *Paradixa fuscinervis* from collection NZ 46 is probably a contamination from a previous collection.

We had little success rearing adults in the laboratory from our collections either in the original highly sulphurous water or in fresh tap water. The majority of larvae died before pupation and few adults emerged even from field-collected pupae. It appears, therefore, that *rotoruae* requires some special factors for successful growth and metamorphosis which is present only in the natural breeding sites. There was a remarkable synchrony in the stage of development of the immature stages in the field, apparently different in the various pools or even parts of pools.

A few adults were found resting in the grass around the breeding sites at the time our collections were made. Nothing definite is known of the bionomics of the adults but it seems probable that the 2 females recorded below were taken landing or biting.

DISTRIBUTION (fig. 32). Material examined: 1416 specimens; 27 ♂, 38 ♀, 1268 larvae, 83 pupae; 21 individual rearings (7 larval, 14 incomplete).

NEW ZEALAND. *South Auckland*: Rotorua, Kuirau Hot Springs Reserve, 23, 27 Dec 1963, BS (NZ 46) type series as listed above [NELS, CANT, USNM, BMNH, UCLA]; Whakarewarewa thermal area, 19 May 1964, F (NZ 185), 1 L [UCLA]. Rotorua, behind baths, hot water, 14 Jan 1944, W. J. Phillips (1), 3 L [NELS]; clear water, temperature 100°F, 3 Jan 1945, Wallwork (503), 6 L [NELS]; stagnant pool, temperature 80°F, 3 Jan 1945, Wallwork (504), 6 L [NELS]; 24 July 1923, O. H. Swezey, 1 ♀ [BISH]; hot pool, 14 Jan 1944, W. J. Phillipps, 1 ♀ [WELL].

12. *Culex (Culex) asteliae* Belkin, n. sp.

Figs. 14, 15, 32

TYPES: *Holotype* ♂ (NZ 68-104) with associated larval and pupal skins, Rangitoto Island, 7 Jan 1964, J. N. Belkin and D. A. Schroeder [NELS]. *Allotype* ♀ (NZ 68-129) with associated larval and pupal skins, same data as holotype [NELS]. *Paratypes*: 52 ♂, 61 ♀, 44 larvae, 122 pupae (NZ 67, 68), same data as holotype except that 4 Jan 1964 for collection NZ 67, as follows: 1 lp♂ (68-102), 1 lp♀ (68-127) [CANT]; 1 lp♂ (68-103), 1 lp♀ (68-128) [USNM]; 1 lp♂ (68-107), 1 lp♀ (68-130) [BMNH]; 5 lp♂ (67-108-110, 114, 120), 4 lp♀ (67-119, 121-123), 4 p♂ (67-103, 104, 107, 116), 6 p♀ (67-102, 105, 106, 111, 113, 118), 1 ♂ (67), 2 ♀ (67), 117 L (67), 7 P (67) [UCLA]; 11 lp♂ (68-101, 106, 117, 118, 136, 141, 143, 149, 152, 159, 175), 13 lp♀ (68-105, 137, 138, 140, 151, 165-168, 174, 178, 181, 182), 24 p♂ (68-111, 115, 119-121, 124, 131, 134, 139, 142, 144-146, 150, 154-158, 160, 162, 164, 169, 177), 24 p♀ (68-108-110, 112, 113, 116, 122, 123, 125, 126, 131a, 132, 135, 147, 148, 161, 163, 170-173, 176, 179, 180), 1 lp (68-153), 4 ♂ (68), 8 ♀ (68), 297 L (68), 24 P (68) [UCLA].

FEMALE. *Wing*: 3.5 mm. *Proboscis*: 1.85 mm. *Forefemur*: 1.6 mm. *Abdomen*: about 2.6 mm. Extremely similar to *pervigilans* from which it is difficult to differentiate; distinguished from *rotoruae* by same features as *pervigilans* and from the latter primarily by the following. Size considerably smaller (smallest in complex), general coloration usually lighter. Torus of antenna often light brown. Mesonotal integument light to dark brown; mesonotal scaling usually less contrasting, predominantly creamy, whitish toward sides and prescutellar area, supraalar area with a conspicuous patch of bronzy scales, a few bronzy curved scales in fossa. Forecoxa with a smaller patch of light scales at base; knee spots and apical hindtibial spot usually yellowish. Abdominal tergal light bands usually larger and straighter; sternites more extensively dark-scaled, light scales usually creamy.

MALE. Even more similar to *pervigilans* than female; mesonotal scaling essentially same as in *pervigilans*. Palpus with long hairs shorter and less numerous, those on segment 3 usually less than 10 and restricted to distal third.

MALE GENITALIA (fig. 14). As figured, apparently indistinguishable from *pervigilans*. Seta *c* of subapical lobe apparently shorter and weaker; 1 to 3 setae in group *d-f*. Proctiger crown apparently with weaker and fewer spicules.

PUPA (fig. 14). *Abdomen*: 2.69 mm. *Trumpet*: 0.58 mm. *Paddle*: 0.75 mm. As figured; in general similar to *pervigilans* and *rotoruae* from which it can be readily separated by the following features. Trumpet slender, index at least 8.0; usually uniformly moderately pigmented; pinna less than 0.18. Cephalothorax, trumpet and abdomen pigmented a bright yellowish brown, lighter on distal segments. Hairs strongly pigmented, conspicuous; hair 5-IV long, usually about 1.5 of length of tergite V. Paddle practically colorless except for strong rib and base; hair 1-P strong, hair 2-P apparently always undeveloped.

LARVA (fig. 15). *Head*: 0.8 mm. *Siphon*: 1.63 mm. *Saddle*: 0.42 mm. As figured; in general similar to *pervigilans* but easily differentiated by the following features. Head capsule uniformly moderately to lightly pigmented except for usual lighter and darker areas; mental plate usually with 8 teeth on each side, moderately pigmented. Antenna uniformly lightly to moderately pigmented except for narrow dark basal ring; length usually about 0.63 of head; spicules shorter and less conspicuous. Prothoracic hairs 7, 8-P usually single, rarely double. Abdominal hairs 1, 6-III-V usually longer. Siphon moderately to lightly pigmented, frequently darkened in distal 0.3; long and slender, very gradually slightly tapered distad, index always more than 8.5; pecten teeth very small, usually less than 10; subventral tufts (1, 1a-S) usually 4 pairs, the middle 2 displaced dorsad, the basal and apical more or less in line with pecten, all tufts usually triple or double and longer than width of siphon. Saddle very deeply and abruptly incised ventrolaterally for ventral brush; saddle hair (1-S) usually strong and double. Anal gills subequal, shorter than saddle and pointed.

SYSTEMATICS. *C. asteliae* is strikingly differentiated from other members of the *pervigilans* complex in the larva and pupa but the adults and male genitalia are very similar to *pervigilans*. Particularly distinctive of *asteliae* is the long slender larval siphon with the 2 median hair tufts above the level of the pecten and the basal and apical tufts in line with the pecten. There is remarkably little variation in the diagnostic characters of the larva and the trumpet of the pupa within and among different populations. Therefore, it seems clear that these characters are genetically fixed and that *asteliae* is a distinct species. I have not seen any larvae of *pervigilans* which could be mistaken for *asteliae* and there is no indication of any intermediate condition which would suggest hybridization between the 2 forms.

To date *asteliae* has been collected only in the Hauraki Gulf area and the adjacent Waitakere Ranges in North Island but its natural range may be coextensive with its principal host plant, the broad-leaf astelia *Collospermum hastatum*. This liliaceous plant on Rangigoto Island is a typical pioneer, growing on bare volcanic rock on the periphery of the island. I believe that the association with this plant may hold the clue to the origin of *asteliae* and I suggest that *asteliae* was formed from a founder population of the *pervigilans* stock on an isolated volcanic island where the only available fresh water was in astelia axils. This event cannot be dated definitely but the relatively wide present distribution of *asteliae* suggests that it was not a very recent one, almost certainly not within the period of man's occupation of New Zealand.

BIONOMICS. The immature stages of *asteliae* have been collected only in the leaf axils of terrestrial and epiphytic broad-leaf astelias, principally *Collospermum hastatum* but possibly also one or more species of the genus *Astelia*. We did not find *asteliae* in other plants which contain axil water in smaller quantity and less regularly, such as nikau palms, *Phormium*, *Cordy-*

line and narrow-leaf species of *Astelia* but it is possible that it may breed in these occasionally. The only other mosquito definitely known to breed in leaf axils of astelias is *Aedes notoscriptus* which we found once in association with *asteliae* (NZ 67) and which has been reported before from astelias (Miller 1920:36; Graham 1929:210). The association of *quinquefasciatus* with *asteliae* in one collection (NZ 93) is probably due to contamination or error in labeling.

The immature stages of *asteliae* were reared without difficulty in the laboratory but this species appeared to require more time than *pervigilans* for the completion of the aquatic cycle. Nothing is known of adult bionomics since this species has never been collected in the field in this stage, even on Rongitoto Island where the immature stages are quite common.

DISTRIBUTION (fig. 32). Material examined: 850 specimens; 67 ♂, 69 ♀, 555 larvae, 159 pupae; 125 individual rearings (58 larval, 63 pupal, 4 incomplete).

NEW ZEALAND. *North Auckland*: Rangitoto Island, 14 Sept 1963, S (NZ 7), 1 lp♂ (7-112), 4 L [UCLA]; 4 Jan 1964, S (NZ 67), 7 Jan 1964, BS (NZ 68), type series as listed above [NELS, CANT, USNM, BMNH, UCLA]. Waitakere Ranges, Karekare Road at crossing of headwaters of Opal Pools, 8 Jan 1964, BES (NZ 82), 1 lp♂ (82-102), 1 L, 1 P [UCLA]. Titirangi Beach, end of Mahoe Road, 11 Jan 1964, BS (NZ 93), 1 lp♂ (93-101), 1 lp♀ (93-102), 1 lp (93-104), 4 L, 2 P [UCLA].

Little Barrier Island: Summit Track, elev. 186 m, 10 Oct 1963, S (NZ 13), 3 lp♂ (13-103, 105, 106), 1 p♂ (13-101), 1 lp (13-107), 8 L [UCLA]; 8 Nov 1963, S (NZ 25), 3 lp♂ (25-101, 106, 110), 1 lp (25-102), 8 L [UCLA]. Summit Track, elev. 267 m, 8 Nov 1963, S (NZ 24), 3 lp♂ (24-101, 102, 104), 1 lp♀ (24-103), 9 L [UCLA]. Summit Track, elev. 75 m, 8 Nov 1963, S (NZ 26), 1 ♀, 3 L [UCLA]. Summit Track, elev. 225 m, 7 Mar 1964, S (NZ 132), 1 lp♂ (132-103), 1 lp♀ (132-107), 1 p♂ (132-106), 3 p♀ (132-102, 104, 105), 41 L, 1 P [UCLA].

South Auckland: Coromandel, 22 Apr 1964, N (NZ 219), 2 L [UCLA].

13. *Culex (Culex) quinquefasciatus* Say

Fig. 33

1823. *Culex 5-fasciatus* Say, 1823:10. TYPE: Sex not specified [New Orleans, Louisiana], Mississippi River, U. S. A. [Lost]. Synonymy with *fatigans* not universally accepted, see Stone (1957:342-343); type locality restricted by Belkin, Schick and Heinemann (1966:4-5).

1828. *Culex fatigans* Wiedemann, 1828:10. TYPE: Lectotype ♀ bearing Wiedemann's handwritten label (lacking on ♂ which also lacks the genitalia), as follows//Ind. orient/Coll. Winthem//fatigans Wied/Ind orient//fatigans/ det. Wiedem.//; PRESENT SELECTION [NMW]. Synonymy with *quinquefasciatus* by Dyar and Knab (1909:34), not universally accepted, see Stone (1957:342-343).

1848. *Culex acer* Walker, 1848:18. TYPE: Holotype ♀, New Zealand [BMNH]. Synonymy with *fatigans* by Edwards (1924:336, 395).

For extensive complete synonymy, see Stone, Knight and Starcke (1959).

C. (C.) quinquefasciatus of Belkin (1962:195-197); Stone (1963:135).

C. (C.) pipiens quinquefasciatus of Stone, Knight and Starcke (1959); Stone (1967:217).

C. (C.) fatigans of Edwards (1924:395; 1928:47; 1932:208); Taylor (1934:24);

Graham (1939:211); Miller and Phillipps (1952:21).
C. (C.) pipiens fatigans of Laird (1956).

FEMALE (Miller and Phillipps 1952:fig. 37, 38). *Wing*: 3.9 mm. *Proboscis*: 2.15 mm. *Forefemur*: 2.0 mm. *Abdomen*: about 2.85 mm. As described by Belkin (1962:195-196); in general similar to members of *pervigilans* complex; differing from *pervigilans* chiefly in the following diagnostic features. General coloration lighter, integument and dark scales lighter, light scales usually creamy instead of white. Thoracic integument lighter, mesonotum uniformly brown, pleuron light brown; mesonotal scales shorter and more numerous, darker in color, largely light brown and not contrasting with integument. Anterior surface of hindfemur entirely pale-scaled at base and on lower surface distally to near apex; posterior and ventral surfaces of all femora largely pale-scaled; knee spots and hindtibial apical spot less conspicuous and more light tan than white; lower surfaces of tibiae and sometimes basal tarsal segments more or less distinctly paler than upper surfaces. Abdominal tergal light scales usually creamy rather than whitish, basal transverse light bands usually more strongly widened in the middle; sternites I-VII usually with pale tan scales only, rarely with a few dark scales in the middle of some segments as in the male (possibly hybrids with *pervigilans*).

MALE. Essentially as in the female but generally paler. Differing from *pervigilans* in the same features as the female except for the following. Abdominal sternites II-VII with some dark scales in the middle usually in the basal 0.5 only, apical half of each segment pale-scaled straight across, without dark scales in posterolateral areas. Palpus apparently somewhat shorter, rarely exceeding proboscis by more than length of segment 5; distal segments with less numerous and shorter hairs; segment 3 usually with less than 15 moderately long external ventrolateral hairs in distal half or less, a more or less distinct pale-scaled line usually present above the hairs.

MALE GENITALIA (Belkin 1962:fig. 97). As figured and described by Belkin (1962:196) and with the following diagnostic features from the *pervigilans* complex. Tergal arms of the outer division of lateral plate of the phallosome relatively short and straight, subparallel, apex acuminate in dorsal aspect, DV/V usually more than 0.7. Basal sternal process short but variable, usually poorly pigmented, rarely moderately pigmented and somewhat elongate but never strongly curved ventrad.

PUPA (Belkin 1962:fig. 97). *Abdomen*: 3.27 mm. *Trumpet*: 0.8 mm. *Paddle*: 0.9 mm. As described by Belkin (1962:196); extremely similar to members of *pervigilans* complex from which it can be distinguished apparently by the strongly oblique pinna whose maximum length is at least 0.4 of the total length of the trumpet.

LARVA (Miller and Phillipps 1952:fig. 39; Belkin 1962:fig. 98). *Head*: 0.79 mm. *Siphon*: 1.02 mm. *Anal Saddle*: 0.4 mm. As figured and described by Belkin (1962:196); in general similar to *pervigilans* from which it is readily distinguished by the following characters. Mental plate usually with at least 9 teeth on each side of median apical tooth; aulaeum much shorter and less conspicuous; head capsule usually moderately to strongly uniformly pigmented. Antenna much shorter (as in *rotoruae*), usually 0.6 or less of head capsule; moderately to strongly pigmented, middle of proximal part lighter, base darkened; spicules well developed dorsally on proximal part, slender except toward hair 1-A, distal part usually without spicules. Abdominal hair 1 usually single or double on III-V. Siphon more or less distinctly swollen near or before middle, apex narrowed; shorter, index usually less than 5.0; subventral tufts (1, 1a-S) usually 4 pairs, subapical distinctly out of line, proximal distad of pecten.

SYSTEMATICS. The ubiquitous *pipiens* complex is apparently represented in New Zealand only by small populations of *quinquefasciatus* which were undoubtedly introduced in ships. In most features these populations are quite similar to populations of *quinquefasciatus* in the tropical South Pacific and elsewhere in the world. However, in one lot of larvae (NZ 69), there is a suggestion of introgression of *pervigilans* characters, particularly in the shape and number of teeth in the mental plate. Although these characters are somewhat variable in extralimital populations and may be temperature dependent, the possibility of hybridization of *quinquefasciatus* and *pervigilans* should not be dismissed without experimental studies.

It is possible that other forms of the *pipiens* complex exist in New Zealand. The females from Waitomo are undoubtedly members of this complex but their assignment to *quinquefasciatus* is provisional only since all forms in the complex are recognized almost exclusively on male genitalic characters.

BIONOMICS. *C. quinquefasciatus* appears to be uncommon in New Zealand and largely confined to coastal areas in the vicinity of the larger ports on North Island where it appears to be definitely established. Our collections of immature stages were made in breeding sites typical of this form in other parts of the world, in a fire drum (NZ 66), a cistern cover and air hole (NZ 69), an oxidation pond in a sewage treatment plant (NZ 180), an abandoned washing machine bowl (NZ 194), and a boat hull (NZ 218). The pupa reported from an astelia axil (NZ 93) is undoubtedly *quinquefasciatus* but this record may be due to contamination or an error in labeling. On only one occasion (NZ 66) was *quinquefasciatus* collected in association with *pervigilans* but the 2 species may occur together more frequently since there is a suggestion of introgression of *pervigilans* characters in several specimens in another collection of *quinquefasciatus* (NZ 69).

Our collections do not support Graham's (1939:211) statement that this species breeds "through the year in any place exposed to full sunlight and holding water charged with organic matter." Graham (loc. cit.) states that he found *quinquefasciatus* (as *fatigans*) in the Auckland District breeding and biting all through the winter and observed pupation and emergence of adults in June. Adults, however, were not encountered in September and October, and he believed that the months of July and August were cold enough to kill them and suggested that the species survived from year to year through "hibernation" of larvae.

DISTRIBUTION (fig. 33). Material examined: 244 specimens; 40 ♂, 43 ♀, 117 larvae, 44 pupae; 18 individual rearings (16 larval, 1 pupal, 1 incomplete).

Widespread in tropical, subtropical and warm temperate regions.

NEW ZEALAND. *North Auckland*: Whangarei, Feb 1924, T. R. Harris, 1 ♀ [BMNH]. Devonport, 18 Feb 1917, D. Miller, 1 ♂ [BMNH]; Shoal Bay, 18 Jan 1917, D. Miller, 1 ♂ [BMNH]. Rangitoto Island, 7 Jan 1964, BS (NZ 69), 5 lp♂ (69-102-106), 3 lp♀ (69-101, 107, 108), 2 ♂, 11 ♀, 66 L, 14 P [UCLA]. Oratia, DSIR Field Station, 30 Dec 1963, S (NZ 66), 1 lp (66-103), 18 L [UCLA]. Titirangi Beach, end of Mahoe Road, 11 Jan 1964, BS (NZ 93), 1 P [UCLA]. Auckland, Avondale, Methuen Road, 9 Aug 1964, F (NZ 194), 1 p♂ (194-124) [UCLA]. Glendion(?), "in banana palm," 20 Mar 1919, D. Miller, 1 ♂ [BMNH]. Erin Bay(?), 24 Mar 1919, D. Miller, 1 ♂ [BMNH]; Erin Park(?), same data, "catch basin," 1 ♂ [BMNH]. Mangere Sewage Plant, 22 Apr 1964, F (NZ 180), 4 lp♂ (180-101, 103, 107, 108), 4 lp♀ (180-102, 104, 105, 109), 23 ♂, 23 ♀, 8 L, 20 P [UCLA].

South Auckland: Coromandel, 21 Apr 1964, N (NZ 218), 8 L [UCLA]. Waitomo, 26 July 1923, G. A. Marshall, 1 ♀ [BMNH].

TRIBE CULISETINI

Genus CULISETA

1902. *Theobaldia* Neveu-Lemaire, 1902:1331-1332. TYPE SPECIES: *Culex annulatus* Schrank, 1776, Europe; original designation. Preoccupied by *Theobaldia* Fischer, 1885; invalid emendation for *Theobaldius* Nevill, 1878 but available name for homonymy.

1904. *Culiseta* Felt, 1904:391c. TYPE SPECIES: **Culex absobrinus* Felt, 1904, New York; original designation.

1915. *Climacura* Howard, Dyar & Knab, 1915:452. TYPE SPECIES: **Culex melanurus* Coquillet, 1902, New Hampshire.

For complete synonymy see Stone, Knight and Starcke (1959).

14. *Culiseta (Climacura) tonnoiri* (Edwards)

Fig. 34

1925. *Theobaldia tonnoiri* Edwards, 1925:258-259. TYPE: *Holotype ♀, Waiho, Westland, N. Z., 16 Jan 1922, A. L. Tonnoir [NELS].

Culiseta (Climacura) tonnoiri of Belkin (1962:284-286); Stone (1961:44); Nye and McGregor (1964:7-8); Dumbleton (1965:137-142); Pillai (1966).

Culiseta (Culiseta) tonnoiri of Stone, Knight and Starcke (1959:220).

Theobaldia (Climacura) tonnoiri of Edwards (1932:106); Taylor 1934:13).

Theobaldinella tonnoiri of Miller (1950:45); Miller and Phillipps (1952:25-26); Ross, Austin et al (1963:20).

FEMALE (Miller and Phillipps 1952:fig. 44-46). *Wing*: 4.7 mm. *Proboscis*: 3.15 mm. *Forefemur*: 2.25 mm. *Abdomen*: about 3.0 mm. As described by Belkin (1962:284-285), with the following diagnostic features. Scales of vertex of head all golden; labium and palpus dark-scaled. Mesonotal, scutellar and pleural integument dull reddish brown, pleuron with lighter areas; mesonotal scales all linear, largely golden but dark brown in large patches on fossa, posterior dorsocentral and upper supraalar areas; pleural scaling very scanty, narrow hairlike golden scales on *apn* and *ppn*, elongate broad semierect creamy scales on upper and lower patch on *stp* and patch in middle of *mep*; 3 to 5 spiracular bristles, 1 strong lower *mep* bristle. Legs dark brown; femora with a subapical light ring; ventral and posterior surfaces of forefemur and midfemur and all but dorsal surface of hindfemur light-scaled. Claws all simple and all with long fine spicules on outer surface. Wing with distinct large dark spots around furcation of Rs and adjacent veins, on furcation of R_{2+3} and furcation of M, formed by numerous scales which are darker than elsewhere; membrane of wing conspicuously infuscated in area of Rs spot; vein Sc with a large patch of long bronzy bristles at base on lower surface. Abdomen with dark scales only but appearing banded on base of segments because of sparser scaling.

MALE (Dumbleton 1965:figs. 1, 2). As described by Dumbleton (1965:138); in general similar to female except for sexual characters. Palpus as long as proboscis or slightly shorter, with dark scales on segments 2-4, segments 4 and 5 subequal. Claws of forelegs and midlegs enlarged, unequal, larger of pair with basal and submedian teeth.

MALE GENITALIA (Dumbleton 1965:fig. 3). As described by Dumbleton (1965:138). Ninth tergite lobe with 3, 4 long, heavy bristles. Sidepiece without scales; basal mesal lobe poorly differentiated, not projecting, with specialized bristles. Clasper about as long as sidepiece, very slender and slightly tapering. Aedeagus large, about twice as long as wide, simple except for acute apex projecting tergally. Paraproct with 2 conspicuous stout curved teeth; cercal setae 3.

PUPA (Dumbleton 1965:figs. 4-6). As described by Dumbleton (1965:140) from a single damaged skin. The following combination of generic and subgeneric characters evident in this skin will separate the species from all other known New Zealand Culicinae. Trumpet with a long slit in the meatus, hair 9-VIII at the posterolateral angle of the segment, hair 1-IX a simple hair, both paddle hairs (1, 2-P) present. The external and internal margins of the paddle have distinct denticles.

LARVA (Belkin 1962:fig. 185; Miller and Phillipps 1952:fig. 47; Nye and McGregor 1964:fig. 5; Dumbleton 1965:fig. 7). *Head*: 0.95 mm. *Siphon*: 1.96 mm. *Anal Saddle*: 0.51 mm. As figured and described by Belkin (1962:285); with the following diagnostic features. *Head* lightly to moderately pigmented; mental plate short and broad, with 9, 10 teeth on each side; hair 6-C single. *Antenna* uniformly darkly pigmented except for black basal ring; longer than head capsule, slender, uniform in width to hair 1-A, narrowed beyond and again distad of hairs 2, 3-A. *Thorax* said to be whitish in life and abdomen reddish or purplish (Miller and Phillipps 1952:26). *Comb* with about 18-21 scales (possibly up to 27 or more) arranged in a single regular row, median scales with black central rod and transparent apex and sides. *Siphon* variable in length, index 6.5-9.0; uniformly lightly to strongly pigmented, with darkened apex and blackish base and acus; pecten teeth usually 8-10, simple or rarely with 1, 2 minute subbasal denticles; hair 1-S very small, at extreme base of siphon, usually 3-5b; hairs 1a-S in a single midventral row, very fine, short, single or double; hair 2-S a rather strong slender apically hooked stiff hair at extreme apex of siphon body; hairs 2a-S in an irregular subdorsal row, 6-8 on each side, very fine, short, single or double. *Saddle* complete; length and width apparently variable, possibly a sexual character; saddle hair (1-X) small, fine, usually 3b; ventral brush with 7 pairs of hairs distad of saddle, 6 pairs of these on grid, usually 3, 4 short hairs on saddle, mostly thick, single or double. Anal gills apparently variable, simple or distinctly constricted near middle.

SYSTEMATICS. Although females of *Culiseta tonnoiri* are very common in West Otago and Westland, the male and the immature stages are poorly known. I have seen a single male from an individual larval rearing (described by Dumbleton 1965). Although the possibility exists that more than 1 species of *Climacura* is present in New Zealand, I believe that the differences in the larvae (constriction of gills, number of comb scales, character of pecten teeth, length and proportions of the siphon and anal saddle) are probably individual or sex dependent variations in a single species. My illustration (Belkin 1962:fig. 185) was made from a strongly flattened larva and the siphon index, the proportions of the anal saddle and the anal gills are distorted. The 2 larvae from South Westland collected by Dumbleton (1965:140) agree very well with the material from Waipoua Forest except for the terminal segments and even in these 2 larvae there is considerable variation in the number of branches in the hairs of abdominal segment VIII. Therefore, I believe that only one highly variable species is present in New Zealand. However, special efforts should be made to rear individually adequate samples from different populations of *Culiseta* to determine the range of variation in *tonnoiri*.

Culiseta tonnoiri is unquestionally related to *antipodea* Dobrotworsky, 1962 from Southeast Australia and to *melanura* Coquillett, 1902 from the Eastern and Central United States, the only other species of *Culiseta* which can be referred to the subgenus *Culiseta* at this time. The correspondence between *melanura* and *tonnoiri* in all the significant characters of the larva and pupa is truly remarkable and can hardly be due to convergence. Dumbleton (1965:137) has pointed out that a similar distribution pattern is known for amphibians and plants.

BIONOMICS. Dumbleton (1965:141-142) discusses the habitat, breeding places, biology and the possible relation of *Culiseta tonnoiri* to disease transmission in man and animals. On North Island *tonnoiri* larvae have been collected only once on 19 March 1945 from "back waters of streams where there is very slow-flowing, or comparatively dead, water sheltered by a dense canopy of foliage and rich in decaying matter including leaves and other debris; among the latter, the larvae of *tonnoiri*, like those of *antipodeus*, hide when alarmed and are difficult to find, but unlike *antipodeus* they appear to develop chiefly during the summer" (Miller and Phillipps 1952:26). In Westland, 2 larvae were collected in January and February 1965 in "permanent ground pools under open forest. The pools appeared to be black, but the water was actually a light amber colour" (Dumbleton 1965:141). Dumbleton suggests that *tonnoiri* is univoltine and breeds primarily in November and December and hibernates as a fertilized female.

This species is found primarily in areas of native forest. Females have been taken landing and biting in December, January and February in Westland and in February and June on North Island. Dumbleton (loc. cit.) reports a few females taken in light traps and in buildings in Westland in October. Biting activity starts shortly after dark. The natural hosts of *tonnoiri* are probably birds. Ross, Austin, et al (1963) have isolated viral agents from *tonnoiri*.

DISTRIBUTION (fig. 34). Material examined: 90 specimens; 1 ♂, 59 ♀, 29 larvae, 1 pupa; 1 individual larval rearing.

NEW ZEALAND. *North Auckland*: Waipoua Forest, H. R. Simpson, 19 Mar 1945 (642), 2 L [UCLA]; 19 Mar 1945 (657), 4 L [NELS]; June 1945 (744), 2 L [UCLA], 1 ♀, 9 L [NELS]; June 1945 (745), 19 ♀ [NELS]; June 1945 (746), 10 L [NELS]. Auckland Watershed Reservoir, 26 Feb 1944, G. Chamberlain, 1 ♀ [WELL].

Nelson: Maruia Springs, 22 Jan 1958, L. J. Dumbleton, ♀ [Dumbleton 1965].

Westland: Lake Moana (Brunner), 16-21 Dec 1925, A. L. Tonnoir, 6 ♀ [CANT]; Lake Ianthe, 11 Jan 1965, L. J. Dumbleton, ♀ [Dumbleton 1965]. Lake Mapourika, 7 Feb 1964, S (NZ 112), 27 ♀ [UCLA]; 1 Feb 1965, L. J. Dumbleton, ♀ [Dumbleton 1965]. Waiho, 16 Jan 1922, A. L. Tonnoir, ♀ holotype, 1 ♀ [NELS], 1 ♀ [BMNH]. Franz Josef Glacier, 30 Oct 1963, L. J. Dumbleton, ♀ [Dumbleton 1965]. Lake Matheson, 16 Dec 1963, L. J. Dumbleton, ♀ [Dumbleton 1965]. Karangarua River, Mar 1950, L. J. Dumbleton, ♀ [Dumbleton 1965]. Copland River, Welcome Flat, Mar 1950, L. J. Dumbleton, ♀ [Dumbleton 1965]. Paringa River, 18 Nov 1950, L. J. Dumbleton, ♀ [Dumbleton 1965]. Blue River, Lake Moeraki, 12 Jan 1965, L. J. Dumbleton, 1 L; 3 Feb 1965, L. J. Dumbleton, 1 lp♂ [Dumbleton 1965]. Haast, 27 Jan 1962, L. J. Dumbleton, ♀ [Dumbleton 1965].

Otago: Martin's Bay, 1-4 Feb 1955, R.R. Forster, 2 ♀ [AUCK]. South Otago, locality not specified, L [J.S. Pillai, in litt. May 1965].

Southland: Milford Sound, Dec 1945, L.J. Dumbleton, ♀ [Dumbleton 1965].

TRIBE MANSONIINI

Genus COQUILLETTIDIA

1905. Coquillettidia Dyar, 1905:47. TYPE SPECIES: *Culex perturbans Walker, 1856 [Charleston, South Carolina], U.S.A. (restriction by Belkin, Schick and Heinemann 1966:3); original designation.

FEMALES. As described by Belkin (1962:303) and with the following distinctive features in New Zealand species. Labium entirely dark-scaled; palpus usually entirely dark-scaled, sometimes with a few pale scales; apical palpal segment minute, without scales. Acrostichal bristles in a complete row; psp bristles absent. Tarsi without light rings. Dorsal scales of wing veins all dark and narrow. Abdominal tergites largely dark-scaled but with basal lateral patches of light scales.

FEMALE GENITALIA. As described by Belkin (1962:303) except that cercus may be upturned and postgenital plate bilobed (tenuipalpis).

MALES. In general as in the females. Palpus about as long as proboscis or distinctly longer, segment 5 well developed.

MALE GENITALIA. As described by Belkin (1962:303) and with the following distinctive features in New Zealand species. Sidepiece simple, more or less cylindrical or conical, without lobes or line of thickened bristles. Claspette short, poorly developed, bearing 1 or more elongate apical spiniforms. Clasper irregular, with 1 apical or subapical spiniform. Aedeagus with spicules or denticles.

PUPAE. As described by Belkin (1962:303) and with the following distinctive features in New Zealand species. Trumpet on a slight tubercle; apex produced into a poorly sclerotized narrow process which is surrounded by a "cellular" lobe on 2 sides, this portion usually broken off in detached pupae. All hairs short and inconspicuous, usually all unbranched including float hair (1-I). All hairs (1-12-C) present on cephalothorax, all normal culicine hairs present on abdomen except 3-VII or 2, 3-VII; hair 1-IX present in iracunda. Paddle without hairs; inner or both inner and outer margins produced beyond apex of midrib.

LARVAE. Only first-instar larvae known for New Zealand species and these are similar to extralimital species which are readily distinguished from all other culicid larvae by characters indicated by Belkin (1962:303) and especially by the unique development of the siphon as follows: short, triangular in outline, without pecten; ventrolateral valve greatly developed, at least as long as body of siphon, with recurved spines near and at apex; median valve with a long sawlike process.

SYSTEMATICS. I am following Ronderos and Bachmann (1963) in recognizing Coquillettidia as a distinct genus instead of retaining it as a subgenus of Mansonia. It may be even advisable in the future to split Coquillettidia into 2 or more genera but this must await better knowledge of the immature stages which are still unknown for most species.

In New Zealand, *Coquillettidia* is represented by 2 very distinct endemic species, one of which, *tenuipalpis*, is so different from typical *Coquillettidia* in numerous basic characters that it is recognized here as constituting a new monotypic subgenus (see below). The other species, *iracunda*, appears to be closely related to the Australian *linealis* (Skuse, 1889), and these 2 species share many characters with *perturbans*, the type species of *Coquillettidia*, but are very different from the majority of palaeotropic species of the *crassipes* group. The latter group should probably be segregated into another subgenus of *Coquillettidia*.

The 2 New Zealand species have very wide, nearly co-extensive distributions on North Island and South Island but neither shows any geographical differentiation.

BIONOMICS. Both New Zealand species of *Coquillettidia* breed in the shallow margins of ponds and small lakes. To date their larvae have not been collected in nature and only the first instar larvae have been obtained from egg rafts by Dumbleton (1967, *in litt.*).

Females attack man readily in late afternoon and at night in the vicinity of breeding sites where both sexes may be found in large numbers resting in the daytime on herbs, grasses and brushy vegetation.

Keys to Species

Adults

1. Base of vein Sc below with large group of bristles; *apn* and *ppn* without distinct scales but with a few short hairs (*Austromansonia*) . . . . 1. *tenuipalpis*
Base of vein Sc below with scales only; apn and ppn with narrow scales (*Coquillettidia*) . . . . 2. *iracunda*

Male Genitalia

1. Aedeagus long and narrow, nearly 5.0 of maximum subapical width; clasper without outer lobe (*Austromansonia*) . . . . 1. *tenuipalpis*
Aedeagus short and broadened subapically, about 2.0 of maximum subapical width; clasper with an outer lobe in addition to small dorsal one (*Coquillettidia*) . . . . 2. *iracunda*

Pupae

1. Apex of paddle produced only on the inner margin; hair 9-VIII at apex of caudolateral angle, or distad; hair 1-IX apparently absent (*Austromansonia*) . . . . 1. *tenuipalpis*
Apex of paddle produced beyond midrib on both inner and outer margins; hair 9-VIII distinctly cephalad of apex of caudolateral angle; hair 1-IX distinct (*Coquillettidia*) . . . . 2. *iracunda*

Larvae

Unknown

Austromansonia Belkin, n. subgenus

TYPE SPECIES: Taeniorhynchus (Coquillettidia) tenuipalpis Edwards, 1924, New Zealand. Only included species.

Austromansonia differs from all other Coquillettidia in the following striking features: in the adults, vein Sc below with a large patch of hairs as in Culiseta, Opifex and Aedes (Nothoskusea), stp and base of pra with a continuous patch of scales, all claws with long fine spicules on outer surface of base; in the male, palpal segments 4 and 5 slightly upturned and with sparse bristles, flagellar segments 12 and 13 together distinctly longer than remainder of flagellum; in the male genitalia, sidepiece without indication of mesal membrane or lobes, aedeagus long; in the pupa, only the inner margin of the paddle produced at apex, hair 9-VIII at apex of caudolateral angle, hair 2-VII present.

Austromansonia seems to be the most primitive and generalized phylad of Coquillettidia and of the entire tribe Mansoniini. The pupal stage has the most complete chaetotaxy of the entire tribe, lacking only hair 3-VII (which is frequently represented by an alveolus) and apparently hair 1-IX. The only other phylad with nearly as complete a pupal chaetotaxy is the iracunda group of Coquillettidia represented by the nominate species in New Zealand and linealis (Skuse, 1889) in Australia. This group, however, is markedly different from Austromansonia in general adult morphology and male genitalia as indicated under iracunda below.

15. Coquillettidia (Austromansonia) tenuipalpis (Edwards)

Figs. 16, 17, 35

1924. Taeniorhynchus (Coquillettidia) tenuipalpis Edwards, 1924:336-367. TYPE: *Holotype ♂ with attached genitalia mount, Ohakune, New Zealand, Jan 1924, T. R. Harris [BMNH].

Coquillettidia (C.) tenuipalpis of Ronderos and Bachmann (1963:50); Stone (1967).

Mansonia (Coquillettidia) tenuipalpis of Edwards (1932:119); Taylor (1934:14); Stone, Knight and Starcke (1959); Belkin (1962:305); Nye and McGregor (1964: 8-11).

Mansonia tenuipalpis of Miller (1950:45); Miller and Phillipps (1952:24).

Taeniorhynchus tenuipalpis of Graham (1939:212).

FEMALE (fig. 16). Wing: 4.83 mm. Proboscis: 3.0 mm. Forefemur: 2.33 mm. Abdomen: about 2.67 mm. As figured here and as described by Belkin (1962:305); with the following diagnostic features. Narrow decumbent scales of vertex pale beige, densely packed along eye margins; broad scales similarly colored, rather elongate; erect scales somewhat darker, rather short. Mesonotal integument dark brown; mesonotal and scutellar scales all golden; pleural scales dingy translucent whitish or pale beige. Abdominal tergites largely bronzy dark-scaled and with extensive basal lateral patches of light scales; sternites largely light-scaled throughout; sternite I completely unsclerotized; sternite II less than 0.5 of III.

FEMALE GENITALIA (fig. 16). Terminal segments very short and deeply retracted into segment VIII. Tergite VIII about 0.5 of VII, with numerous heavy bristles caudolaterally. Sternite VIII subequal to VII and about 2.0 length of tergite VIII, with numerous smaller bristles along caudal margin and in the middle. Membrane between segments VIII and IX very long, particularly between tergites, and containing distinct very slender sclerotized bars (possibly representing intersegmental lines). Insula and sigma represented by a very broad plate articulating with cowl; insula with many short bristles. Tergite IX very narrow, about 0.16 of tergite VIII at its broadest, without bristles in middle, lateral areas bearing 8-12 bristles on each side in tergal half. Cowl with longitudinal basal part articulating with tergite IX and sigma, distal part arched. Tergite X not sclerotized. Cercus compressed, unsclerotized on most of mesal surface; upturned, thumblike, rounded or slightly truncate apically, and bearing many short bristles. Postgenital plate separated by membrane from cowl; small, with 2 distinct lateral lobes bearing numerous short bristles. Atrial plates absent.

MALE (fig. 16). As figured here and as described by Belkin (1962:304-305); essentially as in the female and with the following distinctive features. Palpus slightly upturned, about 1.25-1.3 of proboscis, exceeding latter by full length of segment 5 which is slightly longer than segment 4; apex of segment 3, all of 4 and base of 5 with a few very short hairs. Antenna slightly shorter than proboscis; flagellar segments 12 and 13 together about 1.2 of remainder of flagellum, segment 13 about 1.5 of 12. Claws as figured.

MALE GENITALIA (Belkin 1962:fig. 196; Nye and McGregor 1964:fig. 6). As figured and described by Belkin (1962), with the following corrections and diagnostic features. Segment IX: Tergite lobe poorly defined, with 5-8 bristles; sternite very broad, widely separating sidepieces, with 1 to several pairs of bristles. Sidepiece simple, without any indication of lobe and mesal membrane. Claspette with very long sternal process projecting between sidepieces to nearly base of aedeagus; apex with 2 long spiniforms, one of which is considerably thinner than other. Clasper with a conspicuous postmedian and small preapical dorsal lobe but without outer lobe; base without dorsal ledge. Aedeagus long, cylindrical, poorly sclerotized on dorsal surface; a subapical dorsal process with about 16 short sharp spicules directed cephalad. Paraproct with about 3-6 spines; cercal setae about 5.

PUPA (fig. 17). Abdomen: 4.54 mm. Trumpet: 0.84 mm (without deciduous apex). Paddle: 1.34 mm. Chaetotaxy as figured; diagnostic characters as in the key; all normal culicine hairs present on cephalothorax and abdomen except 1-IX and 3-VII (frequently represented by an alveolus). Cephalothorax lightly pigmented except for darkened dorsal surface; metanotum darkly pigmented. Trumpet very darkly pigmented on tracheoid; bulb (meatus beyond tracheoid to base of triangular sclerite) moderately pigmented; neck (from triangular sclerite to apex of non-deciduous part) not markedly narrowed, lightly pigmented and with smooth apical margin; deciduous apex lacking in all specimens. Abdomen uniformly darkly pigmented; hair 9-VIII at or caudad of prominent caudolateral angle. Paddle uniformly moderately or darkly pigmented; inner margin strongly produced beyond outer.

LARVA. Unknown.

SYSTEMATICS. As indicated under the diagnosis of Austromansonia, tenuipalpis possesses a number of striking features in all known stages which set it apart from all other members of the genus Coquillettidia. In most of these features it appears to be the most primitive living representative of the tribe Mansoniini. Should its larva prove to be as distinctive as the other stages it might be advisable to raise Austromansonia to full generic rank.

BIONOMICS. Pupal exuviae of tenuipalpis have been found in association with those of iracunda in shallow margins of ponds and small lakes choked with herbaceous and grassy vegetation, particularly sedges and reeds. No larvae were found in these areas in spite of repeated search at different times of the year.

Both sexes were swept in numbers from the vegetation in the breeding sites and adjacent banks. A few females have been collected attempting to bite in the vicinity of breeding sites and 3 females were caught in a light trap.

This species does not seem to be as abundant as iracunda and apparently seldom bites man.

DISTRIBUTION (fig. 35). Material examined: 176 specimens, 69 ♂, 97 ♀, 10 pupal skins; no individual rearings.

NEW ZEALAND. North Auckland: Waimauku, Jan, egg laying, D. H. Graham (Graham 1939:212). Bethells Road Swamp, 28, 29 Dec 1963, BFS (NZ 57A, 57B), 35 ♂, 57 ♀, 1 p [UCLA]; 10 Jan 1965, F (NZ 200A), 1 ♂, 4 ♀ [UCLA]; 6 Dec 1966, L. J. Dumbleton (NZ 225), 9 p [UCLA]. Waitakeres, 2 Feb 1950, M. Knight, 1 ♀ [AUCK]; 12 Feb 1950, 1 ♀ [UCLA]; 18 Feb 1950, 1 ♀ [AUCK], 1 ♀ [UCLA]; 25 Feb 1950, 2 ♀ [AUCK]; 26 Feb 1950, 1 ♀ [AUCK]. Piha, May, egg laying, D. H. Graham (Graham 1939:212). Titirangi, 4, 14, 18 Feb 1955, light trap, C. R. Thomas, 3 ♀ [AUCK].

Wellington: Ohakune, elev. 2060 ft, 10 Jan 1920, T. R. Harris, 2 ♂, 1 ♀ [BMNH]; 15 Dec 1922-15 Jan 1923, T. R. Harris, 1 ♀ [BMNH]; Jan 1924, T. R. Harris, holotype ♂, 2 ♂, 4 ♀ [BMNH], 1 ♂, 1 ♀ [UCLA]; pond on bend of Lake Road, 9-10 Jan 1964, BFS (NZ 85A), 27 ♂, 16 ♀ [UCLA].

Otago: Martins Bay, 1-4 Feb 1955, R. R. Forster, 1 ♀ [UCLA].

Southland: Te Anau, in car, 2 Feb 1964, 1 ♀ [UCLA].

Subgenus Coquillettidia

16. Coquillettidia (C.) iracunda (Walker)

Figs. 17, 35

1848. Culex iracundus Walker 1848:6. TYPE: *Holotype ♀ (42-55), New Zealand; identified as the type by E. A. Waterhouse [BMNH].

Coquillettidia (C.) iracunda of Ronderos and Bachmann (1963:50); Stone (1967).

Mansonia (Coquillettidia) iracunda of Edwards (1932:118); Taylor (1934:14); Stone, Knight and Starcke (1959); Belkin (1962:306-307); Nye and McGregor (1964:11).

Mansonia iracundus of Miller (1950:44); Miller and Phillipps (1952:23-24).

Taeniorhynchus (Coquillettidia) iracundus of Edwards (1924:366).

Taeniorhynchus iracundus in part of Graham (1939:212).

FEMALE (Miller and Phillipps 1952:fig. 11). Wing: 4.0 mm. Proboscis: 2.4 mm. Forefemur: 1.8 mm. Abdomen: about 2.7 mm. As described by Belkin (1962:306); superficially very similar to tenuipalpis from which, however, it can be readily distinguished by the following conspicuous features. Size smaller; base of lower surface of vein Sc with broad scales only; apn and ppn with distinct narrow scales; stp scales not extending above bristles to base of pra; abdominal sternites dark-scaled in the middle. Claws with only 1 or 2 long basal spicules on outer surface. Female genitalia not studied.

MALE. Essentially as in the female except for sexual characters; differing markedly in the latter from tenuipalpis as follows. Palpus not upturned, only slightly longer than proboscis; palpal segment 5 slightly shorter than segment 4; apex of segment 3 and all of 4 and 5 with numerous long hairs. Antenna much shorter, less than 0.8 of proboscis; segments 12 and 13 together less than total length of basal flagellar segments, segment 13 distinctly shorter than segment 12.

MALE GENITALIA (Belkin 1962:fig. 196; Nye and McGregor 1964:fig. 7). As figured and described by Belkin (1962), with the following diagnostic features and corrections. *Segment IX*: A small, well-defined tergite lobe bearing 2-5 bristles; sternite not as broad as in *tenuipalpis* but widely separating sidepieces, sometimes with 1 bristle. *Sidepiece* simple, without any indication of lobe; mesal membrane not developed but this area not as strongly sclerotized as in *tenuipalpis*. *Claspette* with sternal process much shorter than in *tenuipalpis*, not projecting beyond level of middle of aedeagus; apex with 1 long heavy, apically truncate spiniform and 1, 2 apically attenuate thickened hairs. *Clasper* with a conspicuous submedian outer lobe in an addition to a poorly defined dorsal lobe which extends from just beyond middle to apex; a conspicuous basal dorsal ledge. *Aedeagus* short and widened subapically, poorly sclerotized on dorsal surface, apex with 2, 3 small teeth on each side dorsomesad; conspicuous ventrolateral denticles extending from base to near middle. *Paraproct* with about 5 large marginal spines and numerous smaller denticles on lower surface; cercal setae usually 2, 3.

PUPA (fig. 17). *Abdomen*: 3.2 mm. *Trumpet*: 0.76 mm (without deciduous apex). *Paddle*: 0.89 mm. Chaetotaxy as figured; diagnostic characters as in the key; all normal culicine hairs present on cephalothorax and abdomen except 2, 3-VII (2-VII sometimes represented by alveolus), hair 1-IX present. Cephalothorax lightly pigmented except for darkened dorsal surface; metanotum moderately pigmented. Trumpet very darkly pigmented on tracheoid; bulb moderately pigmented; neck markedly narrowed, less than 0.5 of bulb width, lightly pigmented and with smooth apical margin; deciduous apex lacking in all specimens. Abdomen uniformly moderately pigmented; hair 9-VIII cephalad of caudolateral angle and distinctly mesad of lateral margin. Paddle uniformly moderately pigmented, lighter than abdomen; both outer and inner margins subequally produced on apex.

LARVA. Unknown.

SYSTEMATICS. Although superficially very similar to *tenuipalpis*, *C. iracunda* is a very distinct species whose closest relative appears to be *lineal is* (Skuse, 1889) from Australia. These 2 species form the distinct *iracunda* group which is very different from the dominant *crassipes* group of the palaeotropics and whose closest relative appears to be the holarctic *perturbans* group on the basis of general adult morphology, pupal trumpet and pupal chaetotaxy.

BIONOMICS. Living pupae and pupal exuviae of *iracunda* have been found in association with *tenuipalpis* in shallow margins of ponds and lakes choked with vegetation. As with *tenuipalpis*, no larvae were recovered from these areas. Graham's report (1939:212) of larvae from "sunny sheltered creek-beds with a temperature of 85°F, and heavily charged with strong-smelling decaying vegetation" at Spirits Bay is undoubtedly erroneous. Unfortunately, the larvae misidentified as *iracunda* by Graham could not be located in any museum in New Zealand and the identity of this species cannot be determined until additional material from this locality is obtained.

C. iracunda appears to be much more abundant than *tenuipalpis*. Both sexes rest in vegetation in the breeding sites and adjacent banks. Females were collected biting in these areas as well as in gullies a considerable distance from the breeding sites. Apparently this species may occasionally enter buildings. According to Graham (1939:212), *iracunda* is a persistent night biter in scrub and bush areas in Auckland Province and is especially troublesome around farms where it pesters the stock.

The presence of *iracunda* on Great Barrier and Mayor islands is of considerable interest and indicates that this species has a considerable flight range and is capable of surviving in very small populations.

DISTRIBUTION (fig. 35). Material examined: 342 specimens, 11 ♂, 211 ♀, 120 pupal skins; 4 individual pupal rearings.

NEW ZEALAND. *North Auckland*: Spirits Bay, 19-24 Feb 1929, W. R. B. Oliver, 5 ♀ [WELL]. Te Kao, 28 Feb 1919, D. Miller, 1 ♀ [USNM]; 1 Mar 1919, D. Miller, 3 ♀ [BMNH]. Kaitaia, Rangitahi bush, 6 Feb 1917, D. Miller, 2 ♀ [BMNH]; Kaitaia Hotel, on wall, 16 Feb 1965, F (NZ 204B), 1 ♀ [UCLA]. Horeke, bush, 18 Jan 1917, D. Miller, 1 ♀ [BMNH]. Pahia, 1 Jan 1953, K. P. Lamb, 1 ♀ [AUCK]; 23 Jan 1946, G. L. Bissett (847), 1 ♀ [NELS]. Kawakawa, bush stream, 13 Jan 1919, D. Miller, 2 ♂, 2 ♀ [BMNH]. Ruakaka, 1 mi S, 20 Dec 1963, BS (NZ 36), 1 p [UCLA]. Bethells Road Swamp, 28, 29 Dec 1963, BFS (NZ 57A, 57B), 1 p♂ (57B-11), 3 p♀ (57B-10, 12, 13), 5 ♂, 50 ♀, 115 p [UCLA]; 10 Jan 1965, F (NZ 200A), 2 ♂, 9 ♀ [UCLA]. Quarry tributary of Waitakere River, edge of Cascade Park, 28 Dec 1963, BF (NZ 59), 5 ♀ [UCLA]. Cascade Park, Waitakere stream, 20 Feb 1964, F (NZ 177), 9 ♀ [UCLA]. Bethells Road, Cascades turnoff, 15 Nov 1964, F (NZ 195A), 1 ♂, 13 ♀ [UCLA]. Waitakeres, 2, 25, 26 Feb 1950, M. Knight, 3 ♀ [AUCK], 2 ♀ [UCLA]. Auckland Watershed Reservoir, 26 Feb 1944, G. Chamberlain, 31 ♀ [WELL], 32 ♀ [UCLA]. Auckland, 10 Jan 1924, G. H. Hopkins, 1 ♀ [BMNH].

Great Barrier Island: Warrens Creek, 16 Feb 1919, D. Miller, 3 ♀ [BMNH].

Mayor Island: 28 Nov 1942, S. A. Rumsey, 1 ♀ [AUCK].

Wellington: Ohakune, 15 Dec 1922-15 Jan 1923, T. R. Harris, 1 ♀ [BMNH].

Westland: Lake Brunner, 2, 4 Feb 1922, A. L. Tonnoir, 2 ♀ [NELS]. Hercules Mt vicinity, Harihari, 7 Feb 1964, S (NZ), 1 ♀ [UCLA]. Lake Mapourika, 7 Feb 1964, S (NZ 112), 12 ♀ [UCLA]. Waiho, 16 Jan 1922, A. L. Tonnoir, 1 ♀ [NELS], 1 ♀ [CANT].

New Zealand, locality not specified: Holotype ♀ (42·55) [BMNH]; 2 ♀ [WELL]; 10 ♀ (683) [NELS].

TRIBE AEDINI

The 6 species of the tribe known to occur in New Zealand are readily recognized from other Culicinae by the following combination of characters. In the adults postspiracular bristles are present. In the pupae, hair 9 on segment VIII is located at the caudolateral angle *and* paddle hair 1-P is present. The siphon of the larvae is distinctive in the presence of a single pair of subventral tufts *and* the ventral brush is strongly developed. A general account of the tribe is given by Belkin (1962:317-318).

SYSTEMATICS AND BIOGEOGRAPHY. The Aedini are better represented in New Zealand than any other tribe of the Culicinae: by the monotypic endemic genus *Opifex*, and 5 species in 4 subgenera (1 endemic) of the widespread genus *Aedes*.

Opifex fuscus probably has retained more important primitive features than any other living representative of the tribe and shows many unique derived features in all stages (see below). It has the widest distribution in the New Zealand area, occurring in the Kermadecs, the main islands of New Zealand and the adjacent islets. It was probably the earliest member of the tribe to reach New Zealand but there is no indication of geographical differentiation in this species.

The subgenus *Finlaya* is represented in New Zealand by *notoscriptus* which has a wide distribution in the Australasian area from the Moluccas to Australia, New Caledonia and the Loyalty Islands. Since it is a semi-domestic species, apparently recovered several times on ships from Sydney in New Zealand ports (Graham 1939:212) and is still largely confined to the vicinity of these areas, I consider that it was probably introduced to New Zealand during and following colonization.

The remaining 4 species of *Aedes* are indigenous to New Zealand in my opinion, and all except *australis* are endemic. *A. australis* is the only member of the subgenus *Halaedes* and occurs elsewhere along the coasts of southeastern, eastern and western Australia, Tasmania and Lord Howe and Norfolk islands. Sharing many features with *australis* is the aberrant *chathamicus*, the only representative of the endemic subgenus *Nothoskusea*, which is known only from Chatham Island. *A. chathamicus* shows more primitive features than *australis* and I consider that it was derived from a stock which also gave rise later to *australis*. The immature stages of both *chathamicus* and *australis* show striking similarities with *Opifex fuscus*, especially in the terminal abdominal segments and the head and abdominal chaetotaxy of the larvae, and the pupal trumpets, paddles and general pattern of abdominal chaetotaxy. Although some of these similarities are undoubtedly due to convergence concomittant with the occupation of similar breeding sites, others are so close that it is evident that they must be due to close genetic relationship. Of the 2 species, *chathamicus* shows more similarities with *Opifex* and this suggests that it is probably an earlier derivative than *australis*. It may have been derived at the same time as *Opifex fuscus*; this is suggested also by the complementary distribution and the striking differentiation of the 2 forms in adult morphology, particularly in *Opifex*, which unquestionably should be regarded as a genus distinct from *Aedes*. The known distribution of *australis* in New Zealand is confined to the southern part of South Island and Stewart Island. This species is sympatric with *Opifex* at least in eastern Otago. It is probable that *australis* is a more recent arrival in the New Zealand area than *chathamicus* and *Opifex*; however, I disagree with Mark's suggestion (*in* Nye 1962:33) that it is a recent introduction and consider that this distribution is a natural one similar to the dispersals of *australis* to Lord Howe and Norfolk islands.

The remaining 2 species of *Aedes* belong to 2 distinct sections of subgenus *Ochlerotatus* (Marks and Nye 1963). *A. antipodeus* has been placed in the Vigilax Section by Marks (1957; Marks and Nye 1963:54) on the basis of general features of male genitalia and it appears to be most similar to *inexpectatus* Bonne-Wepster, 1948 from the highlands of New Guinea on the basis of details of male genitalia, scale pattern of adults and hair 2 of abdominal segments II-VII of the pupa. However, in other pupal characters and larval features the 2 species do not show close affinity. This apparent relationship between a New Zealand species and a species from the highlands of New Guinea is paralleled by that of *pervigilans* and *miraculosus* in the genus *Culex*, according to Marks and Nye (loc. cit.). *A. subalbirostris* appears to be allied to Australian species of the Perkinsi Section and to 2 South African species of *Ochlerotatus* whose affinities seem to be also with this section (Marks and Nye 1963:59). According to these authors this group is obviously an ancient one but insufficient knowledges of its components precludes even a suggestion as to whether *albirostris* represents a derived or a primitive stock. All that can be said safely for the present about the *Ochlerotatus* fauna of New Zealand is that it consists of 2 very distinct species belonging to 2 ancient groups; that *antipodeus* has a wide distribution on North Island and South Island and occurs on some outlying islands

(Little Barrier and Great Barrier); that *subalbirostris* is apparently restricted to South Island from Dunedin district to Invercargill and that it is sympatric with *antipodeus* in this area; and that both species seem to have a wide range in breeding sites and can tolerate at least low salinity.

It is interesting that the indigenous aedine fauna of New Zealand consists entirely of ground pool and rock hole breeders. Since plant container habitats (treeholes and leaf axils) are available and are utilized by other indigenous forms (*Maorigoeldia* and *Culex*), this suggests that container breeding in *Aedes* is a specialization which arose relatively late, after the dispersal of the genus to New Zealand.

KEYS TO GENERA, SUBGENERA AND SPECIES

Adults

1. Erect scales absent on head, instead numerous short curved bristles; scape of antenna a distinct segment proximad of torus (*Opifex*). . . . . 17. *fuscus*
Erect scales present on head; scape of antenna not recognizable as a distinct segment (*Aedes*). 2

2(1). Decumbent scales of vertex of head largely broad; mesonotum with a conspicuous pattern of narrow silvery and golden-scaled lines including a complete continuous lateral prescutal-fossal-posterior dorsocentral line; scutellum with *broad* silvery or light golden scales (*Finlaya*). . . . . .22. *notoscriptus*
Decumbent scales of vertex largely narrow; mesonotum without continuous lateral line as described above; scutellum with narrow scales only 3

3(2). All tarsi with some distinct white-scaled basal bands; female cercus long, narrow and projecting (*Ochlerotatus*) 4
None of the tarsi with distinct white-scaled basal bands; female cercus short, broad and not projecting. 5

4(3). Mesonotum with conspicuous narrow incomplete golden-scaled lines and patches contrasting with dark-scaled background; vertex of head with pair of large submedian patches of narrow dark scales . . . . 20. *antipodeus*
Mesonotal scaling more or less uniform, without conspicuous golden lines or patches; all narrow decumbent scales of vertex pale . . . . .21. *subalbirostris*

5(3). Anterior lower *mep* bristles absent; *ssp* without scales; *psp* usually without scales, rarely with a few narrow ones (*Nothoskusea*) . . . . .18. *chathamicus*
Anterior lower *mep* bristles present; *ssp* with a line of broad light scales; *psp* with numerous broad scales (*Halaedes*) . . . 19. *australis*

Male Genitalia

1. Cercal setae of proctiger of 2 types, short distally, long proximally;

sidepiece without long bristles distally (*Opifex*) . . . . . 17. *fuscus*
Cercal setae of proctiger all short; sidepiece with long bristles distally (*Aedes*) 2

2(1). Claspette short, with numerous bristles or foliform setae and without apical specialized appendage or thickened bristle. 3
Claspette longer, with apical specialized appendage or thickened bristle 4

3(2). Basal tergomesal margin of sidepiece and claspette without foliform setae (*Nothoskusea*) . . . . .18. *chathamicus*
Basal tergomesal margin of sidepiece and claspette with foliform setae (*Halaedes*) . . . . 19. *australis*

4(2). Sidepiece without basal or apical tergomesal lobe, its sternomesal margin with line of lanceolate-tipped setae (*Finlaya*) . . .22. *notoscriptus*
Sidepiece with a prominent basal or apical tergomesal lobe, its sternomesal margin without lanceolate-tipped setae (*Ochlerotatus*). . . . 5

5(4). Sidepiece with a large prominant basal tergomesal lobe and without distinct apical lobe . . . . 20. *antipodeus*
Sidepiece with a small, flat basal tergomesal lobe and a prominent apical lobe .21. *subalbirostris*

Pupae

1. Hair 9-VII ventral in position, simple, short, similar to 9-II-VI (*Opifex*) . . . . 17. *fuscus*
Hair 9-VII dorsal in position, markedly different from 9-II-VI (*Aedes*) 2

2(1). Hairs 10, 11-C usually all single (*Finlaya*) . . . . . . .22. *notoscriptus*
At least hairs 10, 12-C always branched 3

3(2). Paddle width at least 0.75 of total width of segment VIII; trumpet very broad, its length not more than 2.0 width 4
Paddle width less than 0.75 of total width of segment VIII; trumpet longer, its length at less 3.0 width (*Ochlerotatus*) 5

4(3). Abdominal hair 1-I (float hair) usually with not more than 20 simple branches; paddle narrower than entire segment VIII, hair 1-P usually branched (*Nothoskusea*) . . . . .18. *chathamicus*
Abdominal hair 1-I (float hair) with more than 40 compound branches; paddle distinctly wider than segment VIII, hair 1-P usually single (*Halaedes*) . . . . 19. *australis*

5(3). Abdominal hair 2-III-VII spiniform, submedian in position; hair 5-IV, V usually single . . . . 20. *antipodeus*
Abdominal hair 2-III-VII thin, in apical 0.2 of segments; hair 5-IV, V usually double . . . . .21. *subalbirostris*

Larvae

1. Saddle occupying less than 0.5 of circumference of anal segment; gills

tiny, rounded; abdominal hair 6-I-V usually at least triple, hair 7-I usually at least double (Opifex, Nothoskusea, Halaedes). 2
Saddle occupying more than 0.5 of circumference of anal segment; anal gills moderate, tapered or pointed distally; abdominal hair 6-I-V usually double, hair 7-I usually single (Finlaya, Ochlerotatus). . . 4

2(1). Metathoracic pleural group (9-12-T) very small, longest hair less than 0.5 of long hairs in mesothoracic pleural group; pecten reduced to a few teeth; hair 6-S very long, single (Opifex) . . . . 17. fuscus
Metathoracic pleural group at most moderately reduced, longest hair more than 0.5 of long hairs in mesothoracic pleural group; pecten teeth numerous; hair 6-S moderate, branched (Aedes) 3

3(2). Ventral brush with 9 pairs of hairs; pecten teeth in a continuous series from near base of siphon; hair 9-T strongly developed, with many branches, subequal to 9-M (Nothoskusea) . . . . . .18. chathamicus
Ventral brush with 7 pairs of hairs; pecten teeth largely absent from base of siphon; hair 9-T weak, with few branches and much smaller than 9-M (Halaedes). . . . . 19. australis

4(1). Head hair 1-C strongly thickened, sharply hooked mesad apically; ventral brush with only 6 pairs of hairs, all on grid; siphon short, index about 2.0; anal gills longer than saddle (Finlaya). . .22. notoscriptus
Head hair 1-C moderately thick but not sharply hooked mesad apically; ventral brush with at least 7 pairs of hairs on grid and at least 1 detached hair proximad of grid; siphon moderate, index more than 3.0; anal gills shorter than saddle (Ochlerotatus) 5

5(4). Siphon with pecten teeth evenly spaced; head hair 6-C single, 5-C usually at least triple . . . . 20. antipodeus
Siphon with 1 or more distal pecten teeth widely spaced; head hairs 5, 6-C usually both double . . . . .21. subalbirostris

Genus OPIFEX

1902. Opifex Hutton, 1902:188. TYPE SPECIES: *O. fuscus Hutton, 1902; monobasic.

17. Opifex fuscus Hutton

Figs. 2, 18, 37, 38

1902. Opifex fuscus Hutton, 1902:188-189. TYPE: *Lectotype ♂ (I·290), Wellington, N. Z., G. V. Hudson, marked as holotype; PRESENT SELECTION, Hutton did not specify a type specimen in the original description [CANT].

Opifex fuscus of Edwards (1921:73-74; 1924:367; 1926a; 1932:127-128); Miller (1922; 1950:45); Kirk (1923); Wood (1929); Taylor (1934:15); Graham (1939: 213); Lee (1944:47); Knight and Chamberlain (1948); Miller and Phillipps (1952:11); Marks (1958); Stone, Knight and Starcke (1959); Dumbleton (1962); Belkin (1962:322-324); McGregor (1963; 1964; 1965); Nye and McGregor (1964:11-14); Haeger and Provost (1965).

As described and figured by Belkin (1962:322-324) and as figured here; with the following additions and diagnostic features.

FEMALE (fig. 18; Miller 1922:figs. 7-10; Miller and Phillipps 1952:fig. 16). Wing: 4.9 mm. Proboscis: 2.25 mm. Forefemur: 2.0 mm. Abdomen: about 3.0 mm. A medium-sized to large, stocky, gray-pruinose dark mosquito with scanty scaling and uniformly slightly infuscated wing membrane. Head: Interocular space about 0.5 as wide as high, with bristles to its lower margin; frons high and broad above antennae, distance between inner articular points of scapes of antennae about 2.0 of their distance from lower margin of eye. Vertex without erect scales, instead with numerous curved attenuate hairs. Palpus as figured, about 0.28 of proboscis; apical segment (4) club-shaped and with invaginated sense organ within apex of club. Antennae separated at base by distinctly more than diameter of one torus; scape a distinct segment throughout; torus moderately wide and short, its width about 1.6 of its length and a little less than 2.0 of maximum width of flagellar segment 1; flagellar segment 1 a little more than 1.5 length of segment 2; segment 3 a little longer than 2 and slightly shorter than 4, remainder of flagellar segments subequal; flagellar whorls extremely poorly developed, usually with only 6 hairs, none of them longer than the segment except on 2-4. Proboscis (particularly lower surface), palpal segment 4 and flagellar segments 4-13 with dense vestiture of short fine hairs. Thorax: Mesonotal bristles very numerous, essentially as in chathamicus but shorter, heavier and without the concentration and elongation in supraalar and prescutellar areas; parascutellum without bristles. Scutellar bristles not numerous, long ones confined to apical margin of lobes. Pleural bristles as figured, numerous but relatively short except for some thickened ones; middle and lower mep bristles numerous. Legs: Foreleg markedly shortened; bristles on all segments thickened, spiniform but short; plantar surfaces of all tarsi with moderate vestiture of thin hairs projecting beyond scales. Claws of all legs large, those of foreleg a little longer than others; members of a pair equal; all with an inner subbasal long, slender straight tooth; spicules not developed on outer surface of base. Wing: As figured; vein Sc ending on C well before furcation of Rs, its base ventrally with a large patch of bristles. Dorsal surface of veins Sc, Rs, R_{2+3}, R_2, R_3 and M with plume scales, those on Sc broad; remaining veins with small squame scales. Alula with long marginal row of very long, narrow, striated hairlike scales except at base; upper calypter with complete marginal row of long bristles. Abdomen: Scaling very sparse; tergite I with scales; sternite I partially sclerotized, without scales or hairs. Hairs numerous and widespread on all tergites and sternites II-VII but short except laterally.

FEMALE GENITALIA (fig. 18). As figured. Completely retracted into segment VIII, even cerci invisible at rest. Tergite VIII about 0.65 length of sternite, with a few scales and many bristles, fully exposed; sternite VIII strongly compressed, without scales, with numerous bristles and with dense hydrofuge short hairs distally, and with a conspicuous densely spiculose invaginated caudal membrane. Tergite IX represented by a pair of dorsolateral lobes separated middorsally by membrane, apex of lobes with setae chiefly on mesal surface. Insula and sigma continuous, narrow; latter joined to cowl; insula with 2-4 setae on each side of midline. Cowl very broad laterally, with slight lateral atrial expansion; broad ventrally where it is broadly joined to base of postgenital plate. Tergite X not developed. Postgenital plate poorly sclerotized, triangular and with broad base; its ventral surface with numerous setae from base, setae longer on apex. Cercus moderate, broad and with rounded apex; setae numerous on outer surface.

MALE (figs. 2, 18; Dumbleton 1962:fig. 2; Miller 1922:figs. 1-3, 5; Miller and Phillipps 1952:fig. 17). Essentially as in the female but with remarkable sexual differences as follows. Palpus about 0.8 of proboscis, pendent. Antennal torus and flagellar whorls not enlarged; flagellar segments 2-4 with a dorsal basal swelling from which arises a greatly enlarged spiniform developed from one of the whorl bristles, shortest on segment 3 and longest on 4. Foretibia shortened and swollen, with a conspicuous fringe of long narrow scales on ventral surface and dense vestiture of long apically-curved hairs near apex; all tarsal segments with scaling confined to dorsal surface, plantar surfaces with very conspicuous hydrofuge fringe composed of densely packed hairs of varying size, the largest with curved apex; all tarsal segments thickened, segments 2-5 shortened, segment 3 with a long curved apical bristle. Midleg elongated, particularly tarsal segments 1 and 2; hydrofuge fringe as on foretarsus; tarsal segments 2-4 with long curved apical bristle. Hindleg with tarsal segment 1 a little longer than tibia; hydrofuge fringe as on foretarsus and apical bristles as on midtarsus. All leg segments with scaling restricted and with numerous fine hairs. All claws without tooth; those of foreleg tremendously enlarged, longer than segments 3-5 combined. Abdominal scaling more restricted than in female.

MALE GENITALIA (Belkin 1962:fig. 207; Nye and McGregor 1964:fig. 8; Dumbleton 1962:fig. 1; Miller 1922:fig. 6). Segment VIII markedly shortened, only slightly retracted. Segment IX well developed and strongly sclerotized, long but narrow; tergite without lobes but with submedian patch of numerous short hairs; sternite with distinct basal and distal sclerites, without hairs. Sidepiece with long hairs present only on dorsal surface in basal half near the conspicuous lateral angle, remainder of surface, particularly side, with dense hydrofuge pile of short curved hairs; mesal surface with extensive membrane from base to apex. Clasper heavily sclerotized; short; strongly swollen and with small rounded process at base, slender beyond; spiniform very heavy, deeply inserted. Claspette a long simple sclerotized plaque in mesal membrane; with short simple hairs distally. Aedeagus long, simple. Paraproct with a single simple or serrated heavy spine. Cercal sclerite strongly developed, setae numerous, short distally, long proximally.

PUPA (Belkin 1962:fig. 207; Knight and Chamberlain 1948:fig. 24; Miller 1922:figs. 20-24). *Abdomen*: 4.04 mm. *Trumpet*: 0.62 mm. *Paddle*: 1.3 mm. In general similar to *chathamicus* and *australis* but differing markedly in the following important features. Cephalothoracic middorsal ridge very strongly developed. Trumpet short, extremely broad, index about 1.1; strongly compressed, anterior margin straight, posterior curved; pinna terminal, not markedly oblique. Abdominal hair 1 a simple hair with a few branches, not a distinct float hair; hair 3-III caudad of level of hair 5; hair 5-IV, V usually single; hair 9-VII small, single, similar to 9 on preceding segments, inserted on ventral surface near caudolateral margin. Paddle distinctly wider than entire width of tergite VIII, paddle hair 1-P usually single.

LARVA (Belkin 1962:fig. 208; Nye and McGregor 1964:fig. 9; Miller and Phillipps 1952:fig. 18; Lee 1948:fig. 28; Miller 1922:figs. 11-19). *Head*: 0.98 mm. *Siphon*: 1.07 mm. *Anal Saddle*: 0.43 mm. In general similar to *chathamicus* and *australis*; with the following diagnostic features. Head hairs 4, 6-C and 12, 13-C far forward, 7-C very small. Antennal hair 1-A minute, slender, spiniform. Thorax with mesothoracic and metathoracic hairs not markedly approximated. Some of the prothoracic hairs moderately developed and other branched. Metathoracic pleural group (9-12-T) very small, with all hairs single, at about level of hair 8-M but in normal position, far removed distad. Abdominal hairs mostly weak; hair 6-VI relatively strongly developed, not markedly different from 6-V. Comb in a triangular patch of 70 or more scales; scales very small proximally, progressively larger distally, apical scales frequently long thornlike spines. Siphon index usually about 2.0; somewhat swollen in middle, not strongly narrowed apically; acus not developed; trachea greatly expanded in siphon, very dark; pecten represented by a few slender, simple, widely-spaced spines; hair 1-S large, beyond middle of siphon and distinctly ventrad of pecten; hair 6-S very long, barbed. Anal segment without any indication of acus; saddle moderately well developed, covering most of dorsal surface of anal segment; hair 1-X on saddle; ventral brush usually with 8 pairs or 17 hairs. Anal gills extremely short, rounded, the 2 pairs usually subequal.

SYSTEMATICS. Opifex fuscus is undoubtedly derived from the same stock as A. chathamicus and A. australis. The first 2 species have retained in varying degree and number many features which I consider to be primitive for the subfamily Culicinae and, of course, possess many derived characters as well. The more striking features in both instances are found in fuscus and for this reason it is retained in a separate monotypic genus.

The most important primitive features, unique in the tribe Aedini, exhibited by fuscus are: (1) in the adults a fully developed scape of the antenna, and setae instead of erect scales on the vertex of the head; (2) in the pupa, hair 9-VII similar to 9-II-VI. Both sexes have strongly developed bristles on the base of vein Sc; this apparently primitive feature is known elsewhere in the tribe Aedini only in the female of chathamicus (reduced or absent in the male of this species and absent in both sexes of australis). Its larva appears to have the most primitive pattern of the phylad in the following: (1) metathoracic pleural group removed from the mesothoracic, (2) hair 6-VI of the same order of magnitude as 6-V, and (3) anal saddle relatively well developed. The female has the least differentiation of the flagellar segments and the shortest bristles in the flagellar whorls.

The most conspicuous derived features in fuscus are: (1) in both sexes, the development of a dense hydrofuge vestiture on the tarsi, the shortening of the foreleg, and an invaginated pit on the apex of the palpus, (2) in the male, specialization of flagellar segments 2-4 and legs, including tremendous enlargement of the foreclaws, and hydrofuge vestiture of the genitalia, (3) in the pupa, the development of a strong middorsal cephalothoracic ridge and the reduction of the float hair on abdominal segment 1, and (4) in the larva, reduction of metathoracic pleural group and pecten. The derived features of the adults and of the pupa appear to be all related to the unusual method of mating and walking on the water surface in this species.

There is considerable variation in all stages of this species and particularly in the larva (size, comb and pecten) but there is no indication of allopatric differentiation. Even the isolated remote population on Kermadec Islands falls within the range of variation in the populations on the main islands of New Zealand. Probably much of the variation noted is due to differences in food supply in the breeding sites, as indicated by marked differences in size of the immature stages and adults from different sites.

BIONOMICS. Opifex fuscus has been found breeding primarily in brackish, saline and hypersaline rock pools above high tide level. I collected it (NZ 65) in a hole in a dead pohutukawa trunk projecting horizontally out over the shore above high tide level. Larvae have also been taken in a fresh water stream (Dumbleton 1962:24) and in a horse trough (L. C. Pilgrim in Nye and McGregor (1964:12).

The remarkable biology of Opifex fuscus and particularly its mating behavior have received considerable attention (Miller 1922; Kirk 1923; Edwards 1926; Marks 1958; McGregor 1964, 1965; Haeger and Provost 1965). Eggs are laid primarily in small cracks and crannies above the water surface but in the damp zone around the margins of rock pools. More than half of experimentally dried eggs hatched after 6 months. The aquatic cycle is apparently quite long in nature since at room temperature (mean 16.2°C) and normal day length a mean period of nearly 24 days was required from the beginning of the second larval instar to the emergence of adults, with more than 14 days for the fourth larval instar. Experiments similar to those of Woodhill (1936) with Aedes australis indicate that Opifex fuscus has a great salinity tolerance but not as extreme as the former species (McGregor 1965).

Haeger and Provost (1965) established a colony of Opifex fuscus and maintained it at a rearing temperature of 25°-27°C. In the laboratory more precise observations on the biology of this species were made but they are not always in agreement with field observations. The females are autogenous and start to lay eggs 6 days after emergence. Both males and females can emerge from the pupal skin unassisted but this seldom if ever happens in nature. Males spend most of their time on the water surface hunting and competing for surfacing pupae. A male captures a pupa with its forelegs and foreclaws and attaches its claspers and part of the sidepiece to the middorsal cephalothoracic ridge of the pupa. According to McGregor (1965:9), in nature when an adult male captures a male pupa it releases it within 5 seconds of capture. In the laboratory, however, Haeger and Provost (1965:26) found that the attending male does not recognize the sex of the emerging adult until genital contact is established. When the adult begins to emerge the attending male quickly inserts its genital segments into the thoracic region of the pupal skin and appresses his genitalia to the side of the abdomen of the emerging adult. When contact is established with the cerci of an emerging female, genital connection is effected rapidly and the male runs for objects on the side of the container, dragging the dangling female.

Populations of Opifex fuscus may reach very high densities, the surfaces of some rock pools being almost covered by swarms of adults, mostly males. On South Island apparently only larvae are found during the winter months but on North Island and the Kermadecs adults probably are present throughout the year.

Females are said to attack man at night (Graham 1939:213) and to produce a most painful bite (Miller and Phillipps 1952:11).

DISTRIBUTION (figs. 37, 38). Material examined: 1550 specimens; 335 ♂, 169 ♀, 783 larvae, 263 pupae; 69 individual rearings (51 larval, 11 pupal, 7 incomplete).

KERMADEC ISLANDS. Raoul Island: Station, 21-30 Sept 1962, G. A. Samuelson, light trap, 3 ♀ [BISH], 1 ♀ [UCLA]. Lava Pt., 7 Oct 1962, G. A. Samuelson (130), littoral saline and brackish pools, 17 ♂, 27 L [BISH], 10 ♂, 10 L [UCLA]. Locality not specified, 9 Oct 1908 (12), 4 ♂ [CANT].

S. Meyer Island: 15 Oct 1962, G. A. Samuelson (155), shallow littoral brackish pool, 102 ♂, 1 ♀, 4 L, 1 P [BISH], 20 ♂, 4 L, 1 P [UCLA].

Kermadec Islands, locality not specified: Aug 1908, 1 ♂ [WELL].

NEW ZEALAND. Three Kings: Great Island, E. G. Turbott, 17 Apr 1946, 3 ♀, 6 May 1946, 2 ♀, 11 Jan 1951, 1 ♀; Tasman Valley, 5 Jan 1953, G. Archey, 1 ♀ [AUCK; Marks 1958:20].

North Auckland: Kaitaia, 10-11 Oct 1924, 3 ♀ [WELL]. Russell, 30 Mar 1925, 1 ♀ [WELL]; Russell Beach, 1928, D. Miller, 1 ♂ [LOND]. Pahia, 2 Mar 1949, K.P. Lamb, 1 ♀ [AUCK]. Ocean Beach, Whangarei Heads, 31 May 1964, F (NZ 187), 2 lp♂ (187B-105, 109), 7 lp♀ (187B-102-104, 106-108, 111), 1 p♂ (187B-110), 2 lp (187B-101, 112), 123 ♂ (187A), 90 ♀ (187A), 11 L (187B), 16 P (187B) [UCLA]. Hen Is. [NELS; Dumbleton 1962:24]. Whangaporoa Peninsula, 15 Mar 1949, D. Spiller, 1 ♀ [AUCK]. Milford, 4 Mar 1927, D. H. Graham (23-19), 1 ♀ [LOND]. Rakino Island, 24, 25 Jan 1964, F (NZ 172, 173), 1 ♂, 13 L, 1 P [UCLA]. Waiheke Island, 1 Mar 1927, D.H. Graham (23-18), 1 ♀ [LOND]. Eastern Beach, 8 Jan 1945, G. L. Bissett (520), 1 L [NELS]. Little Huia, 30 Dec 1963, BF (NZ 65), 9 lp♂ (65-102, 103, 105, 107-109, 112, 114, 115), 7 lp♀ (65-104, 106, 110, 111, 113, 117, 119), 1 p♂ (65-101), 1 lp (65-118), 6 ♂, 17 ♀, 65 L, 31 P [UCLA].

Mokohinau Islands: Burgess Island, 24 Aug 1955, R.A. Harrison, 1 ♂, 3 ♀ [AUCK]. Lizard Island, 23 Aug 1955, R.A. Harrison, 7 ♂ [AUCK]. On board ship, 11 Mar 1964, S (NZ 135), 8 ♀ [UCLA].

Great Barrier Island: Mouth of Te Wairere stream, 26 Oct 1963, S (NZ 17), 5 lp♂ (17-101, 104, 105, 109, 111), 3 lp♀ (17-102, 103, 106), 1 lp (17-107), 7 ♂, 6 ♀, 60 L, 24 P [UCLA].

Cuvier Island: 24 Oct 1963, S (NZ 14), 6 lp♂ (14-102, 103, 106, 107, 110, 111), 3 lp♀ (14-104, 105, 108), 1 p♀ (14-101), 1 lp (14-109), 4 ♂, 14 L, 8 P [UCLA]; 13 Mar 1964, S (NZ 137), 1 lp♂ (137-103), 8 lp♀ (137-104-106, 108, 109, 111, 114, 119), 6 p♂ (137-110, 112, 113, 115-117), 2 p♀ (137-101, 107), 2 lp (137-102, 118), 521 L, 112 P [UCLA].

South Auckland: Tauranga, 5 Apr 1945, C.W. Dixon (680), 4 ♂, 1 ♀ [NELS].

Wellington: Kapiti Island, 23 Dec 1943 (186), 3 L [NELS]. Somes Island, 19 Oct 1944, R.K. Dell, 4 ♂, 1 ♀, 4 L, 3 P [WELL]. Wellington, G.V. Hudson, lectotype ♂ (I·290), paratype ♀ (I·291) [CANT], 2 ♂ [BMNH]; 1921, G.V. Hudson, 2 ♂, 5 ♀, 23 L, 1 P [BMNH], 1 ♂, 3 L, 3 P [USNM]; (2364), 1 ♂, 1 ♀ [LOND]. Wellington, Breaker Bay, 16-25 Jan 1939, J.T. Salmon, 2 ♂, 2 ♀ [WELL]; 23 Mar 1944, W.J. Phillipps (172), 1 L [NELS]. Wellington, Houghton Bay, 6 Dec 1943, V. Brazendale, 2 ♂, 2 ♀ [WELL]; 10 Dec 1943, Russell, 2 ♂ [WELL]; 30 Mar 1944, W.J. Phillipps (183), 1 L, 1 P [NELS]. Wellington, Island Bay, 15 Jan 1925, 1 ♂, 1 ♀ [WELL]; 18 Jan 1943, W.J. Phillipps, 2 ♀ [WELL]; 22 Nov 1943, V. Brazendale, 1 ♀ [WELL]; 21 Sept 1944 (414), 13 L, 4 P [NELS]; 12 Dec 1953, J.C. Yaldwyn, 98 L, 17 P [UCLA]; 3 Jan 1954, J.C. Yaldwyn, 23 ♂, 11 ♀ [UCLA]; 24 Jan 1957, E.N. Marks [Marks 1958:20]; Apr 1961 [Haeger and Provost 1965]. Wellington, Owhiro Bay, 9 Mar 1944, W.J. Phillipps (125), 1 L [NELS].

Nelson: Cable Bay [Dumbleton 1962:24].

Marlborough: Kaikoura, 11 Feb 1922, Archey, 1 ♂ [CANT], 1961 [McGregor 1964; 1965]. Goose Bay, 4 Feb 1925, A. L. Tonnoir, 7 ♂, 3 ♀ [CANT].

Canterbury: Banks Peninsula, near Akaroa lighthouse, R. L. C. Pilgrim, in horse trough [Nye and McGregor 1964:12]; Murray's Mistake, in fresh-water stream [Dumbleton 1962:24]; spray zone, 1961 [McGregor 1964; 1965].

Otago: Martin's Bay, 1-4 Feb 1955, R. R. Forster, 9 ♂, 1 ♀ [CANT]. Otago Peninsula, Cape Saunders, 24 Feb 1918, 1 ♀ [AUCK; Marks 1958:20], all stages [Nye and McGregor 1964:12]; Sandfly Bay, all stages [Nye and McGregor 1964:12].

New Zealand, locality not specified: 1 Apr 1928, 1 L, 1 P [LOND]; E. S.

Gourlay (138), 1 L [NELS]; 3 Jan 1943, 1 ♀ [UCLA].

Genus AEDES

Subgenus Nothoskusea

1962. Nothoskusea Dumbleton, 1962:20. TYPE SPECIES: *Aedes (Nothoskusea) chathamicus Dumbleton, 1962; original designation, monobasic.

18. Aedes (Nothoskusea) chathamicus Dumbleton

Figs. 19-21, 37, 38

1962. Aedes (Nothoskusea) chathamicus Dumbleton, 1962:20-24. TYPE: *Holotype ♂, bred from pupa, south of Point Weeding, Chatham Is., 18 Nov 1959, L. J. Dumbleton [NELS].

Aedes (Nothoskusea) chathamicus of Stone (1963:175).

In general as described by Dumbleton, with the following additions and corrections. The largest mosquito in the New Zealand area in the adult and immature stages.

FEMALE (fig. 19; Dumbleton 1962:figs. 3, 4). Wing: 6.0 mm. Proboscis: 2.8 mm. Forefemur: 3.4 mm. Abdomen: about 4.0 mm. Large dark species; external morphology as figured. Head: Interocular space about as wide as in Opifex and with short bristles and proclinate narrow golden scales nearly to its lower border; frons high and broad above antennae, distance between inner articular points of scapes of antennae greater than their distance from lower margin of eye. Vertex with sparse vestiture of decumbent or proclinate narrow scales, pale golden in a longitudinal median line and in back, dark bronzy in submedian anterior patch of variable extent; some broad decumbent pale golden or yellowish scales laterally, extending back of orbital margin a variable distance toward midline; erect scales numerous, all dark, very long, slender bristlelike but with truncate irregularly or shallowly forked apex; sides with scattered decumbent pale scales; upper orbital bristles in 2 or more irregular rows, with a pair of longer differentiated ones at upper end of interocular space; lateral orbital bristles in a regular single row; numerous shorter bristles on sides and ventrally following erect scales; clypeus bulging, bare, pollinose. Proboscis distinctly shorter than forefemur; labium entirely dark-scaled; labella long, slender, without scales. Palpus about 0.23 of proboscis; segments 1, 2 and 3 indistinctly separated; 1 short and bare; 2 subequal to 1, with short and long bristles and a few small scales; segment 3 about 2.3 of segment 2, with short and long bristles and numerous scales; segment 4 subequal to 1-3 combined, with short bristles and numerous scales; segment 5 a little shorter than segment 1, spherical and bare; all palpal scales dark. Antennae separated at base by distinctly more than diameter of one torus; subequal to proboscis in length; scape a narrow ring except for conspicuous extension at mesal articular point with torus; torus moderate, width subequal to length and only about 2.4-3.0 maximum width of flagellar segment 1, mesal surface with numerous bristles and a few minute broad scales; flagellar segment 1 a little more than 1.5 length of segment 2, with a few minute scales on mesal surface, hairs numerous, long ones in distal half confined to dorsal and lateral surface; segments 2-13 progressively longer, segment 13 a little less than 2.4 length of segment 2; flagellar whorls poorly developed, usually with only 6 differentiated hairs, the dorsal, ventral and 2 outer long, the 2 inner very short, all progressively shorter on distal segments; segment 13 with apical process and with about 3 moderately long subapical bristles (possibly rudiment of flagellar seg-14, also noted in many other New Zealand Culicinae). Thorax: Mesonotal integument dark brown; scaling entirely narrow, very dense along lines of bristles, sparser in between, predominantly dark bronzy but with a more or less distinct and variable pattern of light golden scales on anterior promontory, usually scattered on acrostichal line with a patch near its middle and its prescutellar end, on middle of lateral prescutal line, at mesal end of fossal line, laterad of prescutellar bristles and above wing root, sometimes forming an incomplete linear pattern. Mesonotal bristles very numerous, short except posterior prescutellar and caudal supraalars; acrostichals in 2 widely separated irregular lines; each dorsocentral line in 2 irregular rows; fossals numerous and merging with anterior dorsocentrals and humerals; a more or less distinct posterior fossal row; supraalars extremely numerous; prescutellars numerous; parascutellum with a strong bristle. Scutellum with strongly differentiated lobes; scales narrow as on mesonotum, midlobe with light golden scales in the middle and dark bronzy laterally, lateral lobes with light golden scales only; bristles very numerous, occupying most of surface of all lobes, varied in size, extremely long caudad. Paratergite long, rather narrow, bare. Pleural integument brown and with darkened areas; pleural scaling very sparse, scales predominantly moderately narrow, semierect and light golden except on ppn where they are dark, present on apn, ppn, ppl, psp, upper and lower posterior stp, below bristles on pra, and middle of mep to upper mep bristles; bristles very numerous, as figured, lower mep bristles absent. Legs: Coxae with large patch of scales on anterior surface, scales all dark on anterior leg, dark on others except for variable number of light scales at base; scaling of remainder dark except for light extreme apices of femora and tibiae and base of hindtarsal segment 1. Femora subequal in length but midfemur a little longer than others; forefemur with large patch of specialized light bristles on apex of anterior surface. Tibiae subequal in length to femora of same leg; that of hindleg a little longer than its femur; fore and particularly hindtibiae with strongly developed apical combs; first tarsal segments progressively longer on fore, mid and hindleg and always shorter than corresponding tibiae; all tarsal segments with rows of minute straight thornlike setae shorter than the scales on plantar surface, particularly strong on first segments. Claws moderately large, subequal on fore and midleg but distinctly shorter on hindleg, members of a pair equal; all with short spicules on outer surface of base and with a rather heavy subbasal tooth as figured. Wing: As figured; vein Sc ending on C well beyond furcation of Rs, its base ventrally with a large patch of moderately long bristles. Dorsal surface of veins Sc, Rs, R_{2+3}, R_2, R_3, M and distal part of 1A with plume scales, narrow on all except Sc, remaining veins with squame scales. Alula with a complete marginal row of long narrow scales except in basal 0.3; upper calypter with complete marginal row of longer bristles except at base; lower calypter bare. Abdomen: Predominantly dark-scaled; tergites II-VII usually with patch of pale scales basolaterally, frequently more or less complete transverse basal pale bands connecting lateral patches, more widely on anterior segments; segment I without scales, its sternite not sclerotized but with 1-3 short bristles on each side, its tergite with very dense vestiture of very long and shorter hairs. Segments II-VII with numerous hairs on tergites and sternites not confined to lateral and apical areas.

FEMALE GENITALIA (fig. 19; Dumbleton 1962:fig. 4). As figured here. Almost completely retracted into segment VII. Segment VIII with only a few scales usually developed; tergite about 0.5 of length of tergite VII; sternite not markedly larger, about 1.25 of tergite VIII and 0.625 of sternite VII. Tergite IX strongly developed, about 0.5 of tergite VIII, separated middorsally into 2 lateral sclerites, each with 5-12 setae distally. Insula and sigma continuous, extremely narrow; latter joined to cowl; insula with 2-4 setae on each side of midline. Cowl very broad laterally, with large atrial expansion, narrowed mesad where it is joined to the broad apically rounded more lightly sclerotized postgenital plate which bears numerous setae distally; a small heavily sclerotized area at center of base of postgenital plate. Tergite X not developed. Cercus broad, subequal in length to tergite IX, with numerous setae laterally and apically.

MALE (fig. 19; Dumbleton 1962:figs. 5, 6). Very similar to female, differing primarily in the following. Palpus about the same length as in the female, similar in structure except that segment 3 is a little longer and 4 a little shorter and segment 2 has numerous scales. Antenna not markedly different from female; torus not distinctly larger, slightly wider in proportion to width of flagellar segment 1; flagellar segments 2, 3 and 4 shorter and apical segments longer as figured. Pleural scaling sparser. Claws essentially as in the female but slightly shorter and not as heavy, subbasal tooth more slender. Wing shorter; basal ventral bristles of Sc not developed or very short. Abdomen distinctly longer than in female and much longer than the wing; scaling of abdomen very sparse, light scaling indistinct; bristles heavier and more numerous.

MALE GENITALIA (fig. 20; Dumbleton 1962:fig. 7). As figured here. Segment IX very narrow; tergite with poorly developed lobes bearing about 10 thin bristles; sternite with a distal patch of more than 20 longer, heavier bristles. Sidepiece with long hairs laterally and ventrally to apex; mesal membrane poorly developed, narrow; tergomesal area with numerous short, heavy simple bristles; sternomesal area with numerous short, thin simple bristles. Clasper heavily sclerotized, sinuous in outline; spiniform short and heavy. Claspette a simple prominent lobe with numerous simple short bristles primarily on outer surface. Aedeagus very small, simple. Paraproct with a single heavy apical tooth; cercal setae all similar, very short, usually 4-8.

PUPA (fig. 20; Dumbleton 1962:figs. 8, 9). Abdomen: 5.5 mm. Trumpet: 0.64 mm. Paddle: 1.28 mm. In general very similar to australis; chaetotaxy as figured here. Cephalothoracic middorsal ridge normal. Trumpet short and broad, index usually about 1.7; broadly flared, not distinctly compressed, both anterior and posterior margins straight, pinna only slightly oblique. Abdominal hair 1-I usually with not more than 20 simple branches; hair 3-III caudad of level of hair 5; hair 5-IV, V usually triple (2-4); hair 9-VII strong, distinctly differentiated from 9 on preceding segments, at lateral margin of tergite. Paddle distinctly narrower than entire width of tergite VIII, paddle hair 1-P usually branched.

LARVA (fig. 21; Dumbleton 1962:figs. 10-13). Head: 1.15 mm. Siphon: 1.34 mm. Anal Saddle: 0.51 mm. In general very similar to australis; body much longer but sclerotized parts not markedly larger; chaetotaxy as figured. Head uniformly moderately pigmented except for darkened caudal areas, margin of foramen magnum and collar; head hairs 5, 6-C both moderately strong, 5-C usually double (1-3), 6-C single; 13-C usually double or triple, moderately strong. Antenna concolorous with head capsule in basal part, slightly darkened distad of hair 1-A; shaft slender but somewhat irregular, with inconspicuous fine spicules; hair 1-A usually with about 10 branches (8-15). Thorax with mesothoracic and metathoracic hairs close together and far removed from prothoracic. Prothoracic hairs all weak but several larger hairs with 3 or more branches. Metathoracic pleural group (9-12-T) moderately large, dorsad of hair 8-M and separated from hairs 6, 7-M by more than twice length of their common basal tubercle, hair 9-T moderate, usually with 10 branches (7-13). Abdominal hairs weak; hair 6-VI about 2.0 of hair 4. Comb in a large patch of more than 100 minute broad scales fringed apically. Siphon characteristically shaped as in the figure; index usually a little more than 2.0; trachea greatly expanded in siphon, black; a distinct narrow attached acus present; pecten in a continuous series or interrupted near the middle, with 12-30 similar teeth often extending to near middle of siphon length; hair 1-S beyond middle. Anal segment with a very small detached ventrolateral acus; saddle largely dorsal but longer than in *australis*; hair 1-X close to saddle; ventral brush usually with 9 pairs of hairs. Anal gills very short, rounded, dorsal pair almost twice as large as ventral.

SYSTEMATICS. *Aedes chathamicus*, as indicated under *O. fuscus*, undoubtedly belongs to the same stock as the latter and *A. australis*. It possesses a number of primitive features and lacks any very striking derivative features of the type present in *Opifex*. It is tempting, therefore, to consider it as the most primitive member of this phylad. However, it lacks the very striking unique primitive features of *Opifex* (see) and therefore it does not seem probable that the latter was derived from it. On the other hand, it is clear that *australis* is a derivative from a *chathamicus*-like stock and in many important features *chathamicus* suggests an intermediate step between *fuscus* and *australis*. I therefore submit that *Opifex* was the first segregate of this phyletic line, followed by *chathamicus* and finally *australis*.

The most important primitive features of *chathamicus* appear to be: (1) interocular space and frons wide, essentially as in *Opifex*, (2) antenna essentially similar in the 2 sexes with relatively small torus and poorly developed bristles in the flagellar whorls, (3) palpus essentially similar in the 2 sexes, segment 5 present, (4) legs without special modifications, claws toothed and with spicules, essentially similar in the 2 sexes, (5) numerous bristles on abdominal segments, (6) female and male genitalia least modified in the phyletic line, and (7) ventral brush of larva most strongly developed. All of these characters except (1), (5), and (7) have been strongly modified in *Opifex* but these are all associated with the unusual sexual dimorphism and mating habits of the latter species.

The derived features of *chathamicus*, intermediate between *Opifex* and *australis*, are: (1) in the adult, differentiation of flagellar segments and bristles in flagellar whorls, (2) in the pupa, differentiation of hair 9-VII, and (3) in the larva, association of metathoracic pleural group with hairs of mesothorax, reduction of hair 6-VI, and reduction of anal saddle. The other derivative features of *chathamicus* are primarily in the reduction of the pleural scaling and the elongation of the male abdomen.

BIONOMICS. The immature stages of *chathamicus* are known only from saline or brackish rock pools at or just above high tide mark. No one other species of mosquito has been found associated with *chathamicus*. Adults of this species have not been encountered in nature, all known specimens were reared.

DISTRIBUTION (figs. 37, 38). Material examined: 364 specimens; 25 ♂, 32 ♀, 211 larvae, 96 pupae; 61 individual rearings (12 larval, 37 pupal, 12 incomplete).

CHATHAM ISLANDS. *Chatham Island*: Rocky coast adjoining cliffs south of Pt. Weeding, near Waitangi, 18 Nov 1959, L. J. Dumbleton, ♂ holotype [NELS]. Te Awarakau, near Waitangi, 25 Feb 1964, S (NZ 150, 155), 4 lp♂ (155-106, 108, 122, 140), 8 lp♀ (150-101, 105, 106, 108; 155-107, 126, 127, 147), 14 p♂ (150-102, 111; 155-104, 105, 109-112, 114, 118, 123, 132, 136, 150), 23 p♀ (150-107, 109; 155-101-103, 113, 115-117, 124, 125, 128-131, 135, 137, 138, 142-146), 12 lp (150-103, 104, 110, 112, 113; 155-119, 133, 134, 139, 141, 148, 149) [UCLA]. Point Durham, rocky coast [Dumbleton 1962:21].

Subgenus *Halaedes*

1914. *Caenocephalus* Taylor 1914:700. TYPE SPECIES: *C. concolor* Taylor, 1914, New South Wales; monobasic. Preoccupied by *Caenocephalus* v. der Wulp, 1898.
1962. *Halaedes* Belkin, 1962:328-329. TYPE SPECIES: *Culex australis* Erichson, 1842, Tasmania; original designation.

19. *Aedes (Halaedes) australis* (Erichson)

Figs. 37, 38

1842. *Culex australis* Erichson, 1842:270. TYPE: Lectotype ♂, Tasmania, Schayer [BERL, 5986; selection of Mattingly and Marks 1955:163].
1856. *Culex crucians* Walker, 1856:432. TYPE: *Holotype ♀, Tasmania (Van Diemen's Land) [BMNH; see Mattingly and Marks 1955:165]. Synonymy with *australis* by Mattingly and Marks 1955:163, 166.
1911. *Culex tasmaniensis* Strickland, 1911:181. TYPE: *Lectotype ♂ with genitalia mount, Tasmania, 21 Nov 1910, Bancroft (185) [BMNH: selection of Belkin 1962:329]. Synonymy with *crucians* by Edwards 1924:387.
1914. *Caenocephalus concolor* Taylor, 1914:700-701. TYPES: syntypes ♂ and ♀, Cronulla, New South Wales, 13 Nov 1911, Mrs. J. B. Cleland [SYDN]. Synonymy with *australis* by Mattingly and Marks 1955:163.
1921. *Aedes (Ochlerotatus) ashworthi* Edwards, 1921:75-76. TYPE: *Holotype ♂, Yallingup, West Australia, Sept 1914, J. H. Ashworth [BMNH]. Synonymy with *australis* by Belkin 1962:329.

Aedes (Halaedes) australis of Belkin (1962:329-331); Stone (1963:128); Nye and McGregor (1964:16); Dobrotworsky (1965:168-170; 1966:142).

Aedes (Pseudoskusea) australis of Mattingly and Marks (1955:163-166); Stone, Knight and Starcke (1959); O'Gower (1959; 1960); Dumbleton (1962); Nye (1962).

Aedes (Pseudoskusea) concolor of Edwards (1924:387; 1926b:113; 1932:158); Taylor (1934:19); Woodhill (1936); Woodhill and Pasfield (1941:207-208); Lee (1944:75); Knight, Bohart and Bohart (1944:26, 51).

Aedes (Pseudoskusea) crucians of Edwards (1924:387; 1932:158); Taylor (1934:19).

Aedes (Pseudoskusea) ashworthi of Edwards (1932:158); Taylor (1934:19); Stone, Knight and Starcke (1959).

As described and figured by Belkin (1962); in general similar to *chathamicus*; with the following diagnostic features, corrections and departure from its other populations and from *chathamicus*.

FEMALE (Dobrotworsky 1965:fig. 65). *Wing*: 5.5 mm. *Proboscis*: 3.4 mm. *Forefemur*: 2.4 mm. *Abdomen*: about 3.33 mm. Large dark species. *Head*: Interocular space distinct but narrow, at its narrowest about 0.23 of its maximum height, without bristles or scales except at extreme upper end; frons a little narrower than in *chathamicus*. Vertex with all the narrow decumbent scales pale; erect scales shorter and broader than in *chathamicus*, more distinctly striated and with widened and forked apex. Labium largely dark-scaled, ventral surface with scattered pale scales or indistinctly pale in basal 0.6 or more. Palpus about 0.2 of proboscis; broader than in *chathamicus*, and with distinctly smaller segment 5; segments 2 and 3 with small dingy pale scales, a few similar pale scales at base of segment 4 particularly laterad, remainder of segment 4 with dark scales. Antennae separated by a little less than diameter of one torus; distinctly shorter than proboscis; torus and first flagellar segment with numerous scales; bristles of flagellar whorls longer than in *chathamicus*. *Thorax*: Mesonotum without linear light-scaled pattern; scales all narrow, mainly bronzy but with scattered golden and light golden scales, more numerous in supraalar area and prescutellar space. Mesonotal bristles much less numerous and shorter than in *chathamicus*; fossals very small and few; parascutellum without bristle. Scutellum with scales all narrow and predominantly pale; bristles less numerous than in *chathamicus*. Pleural scaling extensive, scales all broad, both dingy white and dark iridescent present; *ssp* scale patch extensive, light; *psp* with numerous pale scales; *ppn* scales largely dark; bristles less numerous and shorter than in *chathamicus* but 4, 5 strong anterior lower *mep* bristles present. *Legs*: Scaling dark except for usual light areas of femora, very indistinct pale knee spots and apices of femora. Claws with outer basal spicules and subbasal tooth, essentially as in *chathamicus* except that hindclaws similar in size to others. *Wing*: Base of Sc without bristles; wing scales all dark. Marginal scales of alula shorter and broader than in *chathamicus*. *Abdomen*: Scaling of tergites II-VII largely dark, with variable complete basal transverse white or whitish bands usually narrowed middorsally and widened laterally; scaling of sternites II-VII largely pale, with apicolateral dark patches progressively larger on distal segments. Hairs on tergites and sternites shorter than in *chathamicus*; sternite I without bristles. *Female Genitalia*: essentially as in *chathamicus* but lobes of tergite IX much reduced.

MALE (Dobrotworsky 1965:fig. 65; Mattingly and Marks 1955:fig. 1). Essentially as in the female and differing from *chathamicus* in the following. Palpus about 0.8-0.9 of proboscis, dark-scaled; segment 5 swollen; segments 4 and 5 usually curled up in dry specimens; with numerous long bristles on ventral and outer surface of apex of segment 3 and all of 4. Antenna markedly differentiated; torus greatly enlarged; flagellar segments 1-11 short, with strongly differentiated whorls of very long bristles on lateral and dorsal surfaces, progressively shorter and fewer on distal segments, segment 1 with about 12 dorsal and 12 lateral, segment 13 with about 6 in each group; mesal whorl bristles short but numerous; segments 12 and 13 greatly elongated, together subequal to rest of flagellum, 13 a little longer than 12. Femoral and tibial light spots more distinct than in female. Claws of all legs unequal; those of fore and midlegs greatly enlarged, with anterior member of pair larger and with a toothlike outer basal spicule and a submedian ventral tooth, posterior member smaller and with numerous short subbasal spicules and a submedian ventral tooth; anterior claw of hindleg slightly larger than posterior, both essentially as in female. Wing not shortened, abdomen shorter than wing.

MALE GENITALIA (Belkin 1962:fig. 210; Nye and McGregor 1964:fig. 10; Dobrotworsky 1965:fig. 65; Mattingly and Marks 1955:fig. 2). As figured by Belkin; basically similar to *chathamicus* and with the following diagnostic features. Basal tergomesal area of sidepiece with extensive patch of lanceolate curved striated scales with narrow long base. Clasper slightly widened in basal half. Claspette short, rounded, with numerous flattened curved hairs.

PUPA (Belkin 1962:fig. 210). *Abdomen*: 3.98 mm. *Trumpet*: 0.54 mm. *Paddle*: 1.24 mm. Trumpet short and broad, index about 2.2-2.4; moderately flared; pinna distinctly oblique. Abdominal hair 1-I with more than 40 compound branches; hair 5-II not closely associated with hair 4; hair 3-III cephalad of hair 5; hair 5-IV, V usually double; hair 9-VII weak, removed considerable distance mesad from lateral margin of tergite. Paddle distinctly wider than tergite VIII, paddle hair 1-P usually single.

LARVA (Belkin 1962:fig. 211; Dobrotworsky 1965:fig. 65; Lee 1944:fig. 52; Woodhill and Pasfield 1941:fig. 6). *Head*: 1.02 mm. *Siphon*: 1.09 mm. *Anal Saddle*: 0.34 mm. Head hairs 5, 6-C usually both single, weak; 13-C single, weak. Antennal hair 1-A usually double (1-3). Thorax with mesothoracic and metathoracic hairs close together and far removed from prothoracic. Prothoracic hairs all weak and usually single or double. Metathoracic pleural group (9-12-T) very small, dorsad of hair 8-M and separated from hairs 6, 7-M by little more than length of their common basal tubercle, hair 9-T small, usually with less than 5 branches. Abdominal hairs weak; hair 6-VI about 0.5 of hair 4. Comb in a large patch of 100 or more short, broad, apically fringed scales. Siphon characteristically shaped as in figure, index about 2.0-2.5; trachea greatly expanded in siphon, black; acus not developed; pecten with 2 types of teeth, those at base short and widely spaced, followed by 10-15 long teeth whose bases are contiguous; hair 1-S at about middle of siphon, considerable distance beyond pecten. Anal segment without any indication of acus; saddle restricted to distal half of dorsal surface, hair 1-X far removed from it ventrad; ventral brush usually with 7 pairs or 13 hairs all on grid.

SYSTEMATICS. The New Zealand population of *australis* does not appear to differ in any significant feature from Australian populations I have examined. Marks (*in* Nye 1962:33) suggested the possibility that it may have been introduced from Australia and Nye (loc. cit.) pointed out that "there may be some significance in the fact that these first records have come from the vicinity of the ports of Bluff and Dunedin." I believe, however, that it is more likely that *australis* reached New Zealand through natural dispersal rather than through human agency. The discovery of *chathamicus*, which is undoubtedly a derivative from the same stock as *australis*, indicates that this phyletic line dispersed to New Zealand in the past. I interpret the presence of *australis* as the result of a more recent similar dispersal, perhaps contemporaneously with the dispersal of this species to Norfolk and Lord Howe islands. Such a dispersal may have occurred through wind carriage of eggs from a relatively distant land source to the east of New Zealand across a barrier too great for other species of mosquitoes. The great tolerance of salinity shown by *australis* may have been also a very important factor in its successful dispersal and establishment in New Zealand.

As indicated under *Opifex fuscus* and *A. chathamicus*, *australis* is undoubtedly the most derived member of this common phyletic line. The similarities with *chathamicus* particularly are very striking in all stages and in nearly all cases represent a derived state in australis, as follows: (1) in both sexes, narrowing of the interocular space and frons; differentiation of flagellar segments and bristles in the flagellar whorls; decrease in bristles and increase in scales on thorax and abdomen; complete loss of ventral bristles on vein Sc; (2) differentiation of the antenna, palpus and claws in the male; (3) reduction of tergite IX in the female genitalia; (4) development of specialized scales on the sidepiece and hairs on the claspette of the male genitalia; (5) in the pupa, displacement of hair 3-II and displacement of hair 9-VII; and (6) in the larva, reduction and greater approximation of metathoracic pleural to mesothoracic hairs; reduction in size of hair 6-VI, pecten, anal saddle and ventral brush; loss of acus in siphon and anal segment.

BIONOMICS. The breeding sites of australis in New Zealand appear to be similar to those occupied by O. fuscus, are within splashing or seepage distance of the ocean, and show salinities ranging from 0.3 to 3.6% NaCl (Nye and McGregor 1964:16). In Australia this species breeds only in salt or brackish rock and ground pools at or just above high-tide mark (Mackerras 1926; Woodhill 1936:634; Woodhill and Pasfield 1941:208; Dobrotworsky 1965:170). Experimental studies by Woodhill (1936) indicate that the immature stages have extreme tolerance of gradual concentration of sea-water (emergence of some adults in sea-water with 18% NaCl and survival of larvae for 5 days in 20% NaCl). O'Gower (1959; 1960) has reported on the oviposition behavior and larval ecology of australis in the Sydney area.

In Australia this species is considered to be an important pest in restricted localities a few hundred feet from the breeding sites near the coast (Woodhill 1936:633-634) but australis has not been reported to date to bite man in New Zealand. Experimental studies by Woodhill (1936:634) have shown autogeny and stenogamy in australis.

DISTRIBUTION (fig. 38). Material examined: 1957 specimens; 15 ♂, 41 ♀, 1713 larvae, 188 pupae; 35 individual rearings (22 larval, 11 pupal, 2 incomplete).

AUSTRALIA. Widely distributed along the southeast coast from southern Queensland, through New South Wales, Victoria, Tasmania, South Australia to southern part of Western Australia. LORD HOWE ISLAND. NORFOLK ISLAND.

NEW ZEALAND. Westland: Whataroa, ♂, M. Pillai [Nye and McGregor 1964:16].

Otago: Shag Pt. and Karitane [Nye and McGregor 1964:16]. Otago Peninsula, 19 Aug 1962, E. R. Nye, 1 ♂ [UCLA]; Boulder Beach, 28 Apr 1962, E. R. Nye, 1 ♀ [UCLA]; Hooper's Inlet, 2 Jan 1964, BN (NZ 70), 9 lp♀ (70-101-103, 105-110), 1 p♀ (70-104), 7 ♂, 2 ♀, 187 L, 10 P [UCLA]; Papanui Inlet, 19 Aug 1962, E. R. Nye, 1 ♂ [UCLA]; Cape Saunders, Papanui Inlet, Penguin Beach, Pipikaretu Beach, Potato Point and Purakanui [Nye and McGregor 1964: 16].

Southland: Bluff, 26 Jan 1964, S (NZ 104), 13 lp♀ (104-101-107, 185-190), 9 p♀ (104-108, 109, 114-120), 2 lp (104-110, 191), 5 ♂, 6 ♀, ca 1500 L, 143 P [UCLA]; Bluff, D. D. McGregor [Nye and McGregor 1964:16].

Stewart Island: Deep Bay, boat hull, 21 Dec 1961 [Nye and McGregor]; 27 Jan 1964, S (NZ 106), 1 p♂ (106-105), 2 L [UCLA].

Subgenus Ochlerotatus

1891. Ochlerotatus Lynch Arribalzaga 1891a:374; 1891b:143. TYPE SPECIES:

O. confirmatus Lynch Arribalzaga, 1891, Argentina; selection of Coquillett (1910:577).

For complete synonymy see Stone, Knight and Starcke (1959).

20. Aedes (Ochlerotatus) antipodeus (Edwards)

Fig. 39

1920. Ochlerotatus antipodeus Edwards, 1920:132. TYPE: *Holotype ♂, Karikari Bay, New Zealand, 5 Feb 1916, A. E. Brookes [BMNH; marked as type by Edwards].

Aedes (Ochlerotatus) antipodeus of Edwards (1924:376; 1932:137); Taylor (1934: 15); Graham (1939:212-213); Miller (1950:42); Miller and Phillipps (1952: 16-17); Stone, Knight and Starcke (1959); Belkin (1962:389-391); Marks and Nye (1863:50-54); Nye and McGregor (1964:17-20).

As described and figured by Belkin (1962:389-391) and Marks and Nye (1963:50-54); with the following diagnostic features.

FEMALE (Nye and McGregor 1964:fig. 12; Marks and Nye 1963:fig. 1; Miller and Phillipps 1952:figs. 28-30. Wing: 5.16 mm. Proboscis: 3.33 mm. Forefemur: 2.25 mm. Abdomen: about 3.5 mm. Medium to large dark species. Vertex of head with a pair of large submedian patches of short narrow dark decumbent scales; palpus and proboscis entirely dark. Mesonotum predominantly with narrow dark bronzy scales and with a more or less conspicuous and contrasting pattern of golden scales in narrow lines and patches; prescutal golden line incomplete, ending before scutal angle; parascutellum without bristles. Scutellum with broad median line of narrow golden scales, remainder of scales narrow and dark. Posterior pronotum predominantly with flat broad dark scales; ssp usually without scales; psp usually (always?) with a few whitish broad scales; lower msp bristles absent. Femora not mottled; knee spots inconspicuous; tarsi with narrow basal whitish bands, foretarsus on segments 1 and 2 (sometimes also 3 and 4), midtarsus on 1-3 (sometimes also 4), hindtarsi on 1-4 (sometimes also 5). Claws all with fine spicules on outer surface at base; those of foreleg and midleg with a subbasal inner tooth. Wing scales all dark; vein Sc without basal bristles ventrally. Abdominal tergites II-VII with narrow to moderately broad basal transverse whitish bands connected to larger basal lateral white patches; sternites dark-scaled, with basal lateral white patches.

MALE (Marks and Nye 1963:fig. 1). Essentially as in the female except for sexual differences. Palpus variable in length, usually exceeding proboscis by about length of segment 5, sometimes slightly shorter than proboscis; segments 4 and 5 down-turned and with basal pale scale patches. Fore and midtarsal claws unequal; enlarged claw of foretarsus with a basal and a submedian tooth, that of midtarsus with basal tooth only.

MALE GENITALIA (Belkin 1962:fig. 264; Marks and Nye 1963:fig. 1; Nye and McGregor 1964:fig. 13). As figured most accurately by Marks and Nye. Basal tergomesal lobe strongly developed, with numerous short setae on tergal surface, those on mesal margin of lobe longer and slightly thickened. Clasper strongly swollen in the middle. Claspette filament bristlelike, subequal in length to body of claspette.

PUPA (Belkin 1962:fig. 264; Marks and Nye 1963:fig. 2). Abdomen: 3.4 mm. Trumpet: 0.54 mm. Paddle: 0.94 mm. Chaetotaxy as figured by Belkin and as figured and described by Marks and Nye. Trumpet uniformly darkly pigmented except sometimes for a more strongly darkened apex; usually distinctly narrowed before apex; with slightly oblique pinna. Abdominal hair 2 spiniform on all segments, submedian in position on III-VII; hairs 6-I, II, 7-I, 3-III and at least 5-IV, V all very long, thickened and usually all single.

LARVA (Belkin 1962:fig. 265; Marks and Nye 1963:fig. 2; Nye and McGregor 1964:fig. 14. Miller and Phillipps 1952:fig. 31). Head: 0.96 mm. Siphon: 1.37 mm. Anal Saddle: 0.39 mm. Chaetotaxy as figured by Belkin and described by Marks and Nye. Head hair 1-C moderately heavy and about as long as distance between bases; 6-C usually single; 5-C usually at least triple. Prothoracic hairs 2, 3-P usually branched, weak; 4-P multiple; 8-P long and usually single. Abdominal hairs 1-IV, V weak, usually at least triple. Comb scales in a large patch of 30-45; primarily spatulate and fringed apically; outer scales, particularly ventrally, spinelike and with fringe at base only. Siphon index 3.0-4.0; pecten teeth 17-22, very darkly pigmented, evenly and closely spaced throughout, progressively longer distad; hair 1-S distad of pecten, at about middle of siphon. Anal segment with poorly pigmented detached acus ventrally as figured by Belkin; ventral brush with at least 7 pairs of hairs on grid, usually with 1 additional, unpaired hair, and usually with 1 precratal hair, sometimes with 2-4.

SYSTEMATICS. A. antipodeus has been placed in the Vigilax Section of Ochlerotatus by Marks (1957:72) on the basis of features of the male genitalia and the larval siphon and comb. It appears to be related to inexpectatus Bonne-Wepster, 1948 from the highlands of New Guinea, which it closely resembles in scale pattern of the adults, in the male genitalia and pupa but not in larval features (Marks and Nye 1963:54).

There is considerable variation in the morphology of all stages of antipodeus but no indication in the material at hand of any geographical differentiation.

BIONOMICS. A. antipodeus is evidently a typical flood water ground pool breeder. Immature stages have been found in temporary pools, margins of flooded streams, reservoirs and swamps, and in stream bed pools. All breeding sites for which some data is available have been in partial or dense shade in native bush. Breeding occurs primarily during the colder months of the year, from March through October, but males have been found in November, December, January and February suggesting that at least limited breeding takes place during the summer months. Miller and Phillipps (1952:17) report that F. E. Ellett found larvae quite active during the day in a pool whose nocturnal temperature fell to 13°F and Graham (1939:213) found full development to the pupal stage at temperatures no higher than 42°F and completion of the entire aquatic cycle in 3 weeks at 52°F. Females have been observed laying eggs on slime and mud in the winter and larvae have been found in abundance within 24 hours of flooding of dry depressions (Graham, loc. cit.)

Females are active throughout the year and bite at any time of day or night (Graham 1939:212-213). Several have been collected in buildings but there are no definite records of their biting humans indoors. Judging by the number of collections at hand antipodeus is readily attracted to humans out-of-doors but the small number of individuals represented in most collections suggests that populations of this species are seldom large. There are no reports of antipodeus attacking cattle or other animals.

DISTRIBUTION (fig. 39). Material examined: 194 specimens; 20 ♂, 96 ♀, 46 larvae, 32 pupae; 5 individual rearings (3 larval, 2 incomplete).

NEW ZEALAND. North Auckland: Karikari Bay, 5 Feb 1916, A. E. Brookes, holotype ♀, 13 ♀ [BMNH]. Kaitaia, 5 Feb 1917, D. Miller, 1 ♂, 1 ♀ [BMNH], 1 ♂ [USNM]. Whangaroa, 25 Jan 1917, D. Miller, 1 ♀ [BMNH]. Russell, 24 Jan 1917, D. Miller, 2 ♂, 1 ♀ [BMNH], 1 ♀ [USNM]. Waipoua Forest, 5-7 July 1937, J.M. Valentine, 1 ♀ [BISH]; Waipoua, D.H. Graham, 1 ♂ [Marks and Nye 1963:52]. Nihotupu, 25 Feb 1923, A. L. Tonnoir, 1 ♀ [NELS]. Waitakeres, 20, 26 Feb 1950, M. Knight, 2 ♀ [AUCK]; in house, 27 Dec 1950, K.P. Lamb, 1 ♀ [AUCK]. Auckland Watershed Reservoir, 26 Feb 1944, G. Chamberlain, 9 ♀ [WELL]. Titirangi, 1 July 1946, G.L. Bissett, 1 L (972), 8 L (973), 7 L (974) [NELS]; D.H. Graham, 20 Jan 1927, 1 L, 11 Sept 1929, 1 L, 13 Sept 1929, 6 P [Marks and Nye 1963:52, 54]. Auckland, Herne Bay, 24 Feb 1918, T.R. Harris, 1 ♀ [BMNH].

Little Barrier Island: Small stream between Te Waikohare and Tirikikawa streams, 9 Oct 1963, S (NZ 11), 1 ♀, 3 L, 3 P [UCLA]; 6 Mar 1964, S (NZ 128), 2 L [UCLA]. Summit Track, elev. 267 m, 9 Oct 1963, S (NZ 12), 1 lp♂ (12-107), 2 lp♀ (12-106, 108), 2 lp (12-102, 109), 1 ♂, 3 ♀, 12 L, 17 P [UCLA]. Inside bunkhouse, 29 Oct 1963, S (NZ 18), 2 ♀ [UCLA]. Ranger's house, 30 Oct 1963, S (NZ 19), 5 ♀ [UCLA]. Locality unknown, 7 Nov 1963, S (NZ 33), 1 ♀ [UCLA]; 25 Nov 1954, R.A. Harrison, 2 ♀ [AUCK]; 4 Dec 1929, 1 ♂, 2 ♀ [AUCK].

Gisborne: Lake Waikaremoana, 8 ♀ [Marks and Nye 1963:51].

Wellington: Mt. Ruapehu, Jan 1921, M.N. Watt, 1 ♀ [USNM]. Ohakune, 15 July 1922-15 Jan 1923, T.R. Harris, 1 ♂ [BMNH]. Palmerston North, 11 Aug 1944, Reid (399), 1 L [NELS]. Tehoro, 16 Feb 1911, R.F.L. Burton, 3 ♀ [BMNH]. Paraparaumu, Jan 1925, 1 ♀ [WELL]. Masterton, 15 Aug 1944, F.E. Ellett (398), 4 L, 5 P [NELS]; 28 Aug 1944 (416), 2 L [NELS]; 15 Aug 1945, W.J. Phillipps (795), 1 ♂, 3 ♀ [NELS]. Day's Bay, 29 Nov 1921, A.L. Tonnoir, 1 ♂ [NELS].

Nelson: Canaan Beech Forest, 4 Jan 1964, BG (NZ 76A), 1 ♀ [UCLA]. Tasman, 10 Oct 1922, R.J. Tillyard, 1 ♀ [NELS]. Nelson, 28 Sept 1923, A. L. Tonnoir, 1 ♀ [NELS]. Tahunanui, 10 Mar 1964, S (NZ 157), 1 ♂, 1 L, 2 P [UCLA]. Aniseed Valley, 8 Sept 1922, Philpott, 1 ♂ [CANT].

Westland: Lake Moana [Brunner], 16-21 Dec 1925, A. L. Tonnoir, 3 ♂, 8 ♀ [CANT].

Canterbury: Kaiapoi, 21 Jan 1964, S (NZ 99), 7 ♀ [UCLA]. New Brighton, 11 May 1921, 1 ♀ [BMNH]; 5 Nov 1921, 1 ♀ [CANT]; Dyer's Road, 11 Nov 1922, J.W. Campbell, 1 ♂, 1 ♀ [BMNH], 1 ♂ [CANT]. Christchurch, 21 Oct 1924, A.L. Tonnoir, 1 ♂, 3 ♀ [CANT]. Akaroa, 12 Dec 1924, A.L. Tonnoir, 1 ♀ [CANT]. Mt. Grey, Jan 1925, J.W. Campbell, 1 ♀ [BMNH].

Otago: Otago Peninsula, Papanui Inlet, Pipikaretu Beach, Taiaroa Head and near Victory Beach [Nye and McGregor 1964:20]. Taieri Plain, near Dunedin [Nye and McGregor 1964:20]. Stuart's Gully, 6 Nov 1921, C.P. Alexander, 3 ♂, 4 ♀ [USNM].

Stewart Island: Locality not specified, coll. Hutton, 1 ♀ [CANT].

21. Aedes (Ochlerotatus) subalbirostris Klein and Marks

Figs. 22, 23, 39

1960. Aedes (Ochlerotatus) subalbirostris Klein and Marks 1960:115-116.
TYPE: *Holotype ♀, Invercargill, New Zealand, 23 Nov 1886, W. Wesché [BMNH].

Aedes (Ochlerotatus) subalbirostris of Stone (1961:39); Belkin (1962:395-396); Marks and Nye (1963:56-60); Nye and McGregor (1964:20-22).

Aedes (Ochlerotatus) albirostris of Edwards (1925:376; 1932:137); Taylor (1934: 17); Miller (1950:42); Stone, Knight and Starcke (1959).

As described by Klein and Marks (1960:115-116) and as described more fully and illustrated by Nye and Marks (1963:56-60); with the following diagnostic features.

FEMALE. Wing: 5.5 mm. Proboscis: 3.0 mm. Forefemur: 2.25 mm. Abdomen: about 3.5 mm. Large dark species. Vertex of head without distinct submedian patches of dark scales; palpus predominantly dark-scaled but with some whitish scales on apices of segments and scattered elsewhere; proboscis with variable amount of pale-scaling usually restricted to basal 0.75 (except for extreme base), sometimes forming a more or less distinct broad submedian pale ring. Mesonotum without distinct linear pattern, mainly with narrow golden scales except for patch of creamy scales above wing root and prescutellar area; parascutellum without bristles. Scutellum with all scales narrow and creamy. Posterior pronotum with narrow curved creamy scales above, a variable number of elongate flat black scales in the middle and broad creamy white scales below; ssp with a large patch of broad whitish scales, sometimes divided; psp with similar scales; lower msp bristles absent. Femora mottled, predominantly pale-scaled; knee spots inconspicuous; tibiae with some pale scales at base and apex; tarsi with very narrow basal whitish bands, foretarsus on segments 1-3 and sometimes some white scales on 4, midtarsus on segments 1-3 and some basal white scales on 4 and 5, hindtarsus on segments 1-4 and a patch on 5. Claws all with fine spicules on outer surface and all with subbasal inner tooth. Wing with dark scales except for small patch of pale scales at base of vein C. Abdominal tergites I-VII with more or less complete straight narrow basal pale transverse bands confluent with basal lateral triangular white patches, some pale scales apically and sometimes near middle of tergites; sternites predominantly pale-scaled, with some dark scales near base or lateral preapical dark patches which may be joined.

MALE (Marks and Nye 1963:fig. 2). Essentially as in the female except for following sexual differences. Palpus exceeding proboscis by about 0.33 of segment 5; apparently up-turned from base of segment 3; scales dark except for pale band at base of segment 3 and base of 4 and sometimes at few pale scales at base of 5; numerous long hairs on apex of segment 3 and on segments 4 and 5. Labium entirely dark-scaled or with a few slightly paler scales ventrally. Femora darker than in female; tarsi with pale scaling even more restricted. Fore and midtarsal claws unequal, enlarged claw on both legs with a basal and a submedian tooth. Wing without pale scales at base. Abdominal tergites with straight basal transverse pale bands, no apical light scales on II-V; sternites largely dark-scaled except for basal lateral pale patches and usually apical median pale patches.

MALE GENITALIA (fig. 22; Marks and Nye 1963:fig. 3; Nye and McGregor 1964:fig. 15). As figured here and as described and figured by Marks and Nye; with the following diagnostic features. Sidepiece with prominent apical tergal lobe with minute setae on its mesal and sternal surface and 2 conspicuous long differentiated bristles near its base on tergal surface; basal tergomesal lobe not prominent, largely mesal in position, with numerous moderately long setae, none differentiated; sternal surface toward the mesal margin with 3, 4 rows of mesally directed long setae, the most lateral of these very heavy, others thin. Clasper slightly expanded in basal half. Claspette filament almost 1.5 of body, flattened and slightly expanded in distal 0.67 before the curved tapered tip.

PUPA (fig. 22; Marks and Nye 1963:fig. 3). *Abdomen*: 4.25 mm. *Trumpet*: 0.77 mm. *Paddle*: 1.2 mm. Chaetotaxy as figured here and as described by Marks and Nye. Trumpet uniformly moderately pigmented except for slightly darkened apex; distinctly flared apically; pinna distinctly oblique. Abdominal hair 2 thin on all segments, in distal 0.25 on III-VII; hairs 6-I, II, 7-I all long, single, moderately thickened except for thin attenuate apex; 3-III, 5-IV-VI moderately long, moderately thickened and usually all double.

LARVA (fig. 23; Marks and Nye 1963:fig. 4; Nye and McGregor 1964:fig. 16). *Head*: 1.08 mm. *Siphon*: 1.45 mm. *Anal Saddle*: 0.45 mm. Chaetotaxy as figured here and as described by Marks and Nye. Head hair 1-C thin and distinctly shorter than distance between bases; 5, 6-C both usually double. Prothoracic hairs 2, 3-P both single and thickened; 4-P single or double; 8-P very short, branched. Abdominal hair 1-IV, V thickened, usually double, rarely triple. Comb scales in a very large patch of 60-100 in about 5 rows; scales small with widened rounded tip, finely fringed throughout. Siphon index about 2.6-3.5; pecten teeth 13-17, very darkly pigmented, 1-3 distal teeth widely separated from others and considerably larger; hair 1-S distad of pecten, at about 0.67 from base of siphon. Anal segment with very poorly pigmented detached elongate acus ventrad of saddle as figured; ventral brush usually with at least 7 pairs of hairs on grid (8 according to Marks and Nye) and 2-3 precratal unpaired hairs.

SYSTEMATICS. This species was confused with *albirostris* (Macquart, 1850), whose type locality was erroneously indicated as Akaroa by its author, until Klein and Marks reexamined the type material of the latter and the single female from Invercargill which Edwards provisionally referred to as *albirostris* despite a number of discrepancies with the original description. Klein and Marks showed that *albirostris* came from New South Wales and that it is conspecific with *vigilax* (Skuse, 1889), and described *subalbirostris* as a new species on the basis of the unique specimen from Invercargill. Additional females were captured by L. J. Dumbleton (1963:26-27) in the Catlins district in 1958 and 1959 but the immature stages and the males were not known until 1962 when E. R. Nye and D. McGregor found the breeding sites of this species on the Otago Peninsula and associated all the stages through rearings.

A. subalbirostris shows sexual dimorphism in leg markings, an unusual condition in Australian *Ochlerotatus* according to Marks and Nye (1963:59). In the opinion of these authors it appears to fall into the Perkinsi Section as defined by Marks (1957) and modified by Dobrotworsky (1960) but seems to be no more closely related to the Australian members of this section than to 2 South African species which are allied to this section (Marks 1959). Marks and Nye (1963) consider that the present knowledge of this ancient group is insufficient to suggest whether *subalbirostris* represents a derived or a primitive stock.

BIONOMICS. *A. subalbirostris* has been found breeding in all but one instance in association with *antipodeus* in ground pools where it was the dominant species. It has been recorded once breeding alone in a horse trough on the Taieri Plain. In Otago both species favor clean fresh water even in close proximity to the sea (Nye and McGregor 1963:20).

Females of *subalbirostris* are attracted to man occasionally and may enter buildings as indicated by their capture in the Catlins District (Dumbleton 1963) and in a hotel (holotype). As in the case of *antipodeus*, populations of *subalbirostris* apparently do not reach high levels of density.

DISTRIBUTION (fig. 39). Material examined: 27 specimens; 5 ♂, 6 ♀, 11 larvae, 5 pupae; 5 individual larval rearings (3 ♂, 2 ♀).

NEW ZEALAND. *Otago*: Otago Peninsula, Hooper's Inlet, 3 Aug 1963, N (NZ 223), 3 lp♂ (223-10, 11, 13), 2 lp♀ (223-12, 14), 6 L [UCLA]; Hooper's Inlet, Papanui Inlet, Pipikaretu Beach [Marks and Nye 1963:59]; Tairoa Head and near Victory Beach [Nye and McGregor 1964:20]. Taeri Plain, near Henley, 23 Sept 1962, E. R. Nye, 2 ♂, 3 ♀ [UCLA]; Taeri Plain [Marks and Nye 1963: 59]. Catlins District [Marks and Nye 1963:56].

Southland: Invercargill, 23 Nov 1906, W. Wesché, holotype ♀ [BMNH].

Subgenus *Finlaya*

1903. *Finlaya* Theobald, 1903:281-283. TYPE SPECIES: *Culex kochi* Doenitz, 1901, New Guinea; selection of Blanchard (1905:415).

For complete synonymy see Stone, Knight and Starcke (1959).

22. *Aedes (Finlaya) notoscriptus* (Skuse)

Fig. 40

1889. *Culex notoscriptus* Skuse, 1889:1738-1740. TYPES: Syntypes, ♂, ♀, Sydney, Australia, Masters and Skuse (MACL].

Aedes (Finlaya) notoscriptus of Edwards (1922:100; 1924:382; 1932:152); Graham (1929:205-215); Taylor (1934:18); Woodhill and Pasfield (1941:205); Lee (1944:57); Knight, Bohart and Bohart (1944:38, 53); Knight and Marks (1952:558-559); Laird (1954:286-287); Iyengar (1955:27; 1960:61); Rageau (1958a:877; 1958b:3); Stone, Knight and Starcke (1959); Belkin (1962); Dobrotworsky (1965:131-133; 1966:140-141); Steffan (1966:208).

Aedes notoscriptus of Graham (1939:212); Perry (1950:112); Miller (1950:42-43); Miller and Phillipps (1952:12-15).

Ochlerotatus notoscriptus of Miller (1920).

As described and figured by Belkin (1962:348-349); with the following diagnostic features and significant differences from extralimital populations.

FEMALE (Dobrotworsky 1965:fig. 49; Miller and Phillipps 1952:figs. 19, 21-23, 25; Graham 1929:figs. 1-10). *Wing*: 4.1 mm. *Proboscis*: 2.6 mm. *Forefemur*: 2.15 mm. *Abdomen*: about 3.0 mm. A small to medium-sized brown mosquito with conspicuous narrow predominantly golden lines forming a lyre-shaped pattern on mesonotum, scutellum with broad silvery scales, proboscis and tarsi banded with white. *Head*: Orbital line silvery; median, posterior and lateral decumbent scales of vertex golden, remainder blackish; proboscis with narrow submedian ring of pure white scales; palpus, tipped with silvery scales. *Thorax*: Acrostichal and dorsocentral bristles strongly developed, in complete rows; integument light brown. Acrostichal light-scaled line and its prescutellar forks silvery with slight yellowish tinge; anterior dorsocentral light line always present and long, almost reaching anterior border, distinctly golden; posterior fossal line broadened caudally, distinctly golden; lateral prescutal-posterior fossal-posterior dorsocentral light line continuous, broadened from scutal angle to prescutellar space, usually silvery except from posterior end of fossal line to prescutellar space where it is golden; supraalar line long, silvery; prealar patch silvery; silvery broad scales of scutellum with slight yellowish tinge; paratergite and pleural scales patches silvery except on upper part of ppn where they are blackish. Legs: Longitudinal light-scaled lines of femora and tibiae dingy white; fore and midtarsi with small basal white markings only on segments 1 and 2; hindtarsal white markings usually present on segments 1-4 only, narrow, about 0.25 of segment length on 2, segment 5 light brown, sometimes with a few to numerous white scales at base dorsally. Abdomen: Tergites usually with distinct median dorsal basal white or dingy markings widened in the middle but not joined to lateral silvery spots; predominant scaling of sternites varied from light golden to dark.

MALE (Miller and Phillipps 1952:fig. 24; Graham 1929:fig. 11). Essentially as in the female except for usual sexual differences; lateral light line of mesonotum usually not as distinctly broadened as in female and usually silvery throughout; hindtarsal segment 5 usually with more numerous white scales; abdominal tergites III-V usually with broad straight basal dorsal bands joined to lateral silvery spots.

MALE GENITALIA (Dobrotworsky 1965:fig. 49; Belkin 1962:fig. 226; Graham 1929:fig. 12). Apparently indistinguishable from other populations. Sidepiece long and slender; lanceolate-tipped setae varied in number and extent. Clasper shorter and more swollen in basal 0.5 than shown by Belkin (1962) and Dobrotworsky (1965).

PUPA (Belkin 1962:fig. 226; Graham 1929:figs. 23, 24). Abdomen: 4.0 mm. Trumpet: 0.6 mm. Paddle: 1.0 mm. Diagnostic characters as in the key; chaetotaxy as figured by Belkin (1962) for New Caledonia population, except as noted and with considerable variation in branching. Abdominal hair 1-II with 3-10 branches, usually simple, rarely weakly dendritic; hairs 3-III, 5-IV, V weaker and shorter, especially 3-III, none usually as long as tergite following.

LARVA (Belkin 1962:fig. 227; Dobrotworsky 1965:fig. 49; Miller and Phillipps 1952:fig. 26; Lee 1944:fig. 35; Woodhill and Pasfield 1941:fig. 3; Graham 1929:figs. 14-22). Head: 0.89 mm. Siphon: 0.55 mm. Anal Saddle: 0.32 mm. As figured by Belkin (1962); diagnostic characters as in the key. Larger than in most other populations; comb scales in middle of posterior row elongate; comb scale patch variable; siphon index about 2.0 or slightly less; saddle hair usually with 3 or more branches.

SYSTEMATICS. The adults of the New Zealand populations of notoscriptus have a very characteristic facies quite different from that of any of the other population I have seen. They are characterized by the following features in the female: (1) a considerably larger size, (2) predominantly golden lines on the mesonotum, especially the long anterior dorsocentral one, (3) hindtarsal segment 5 largely dark, and (4) basal abdominal light bands widened in the middle and not reaching the lateral silver spots. However, all of these features except the larger size are found sporadically in extra-limital populations of notoscriptus which exhibits a very wide range of variation of coloration throughout its extensive known range. Similarly the characteristic, rather constant, features of the immature stages mentioned in the diagnosis above occur sporadically in other populations, notably in some populations in Australia and New Caledonia. The male genitalia of the New Zealand populations show no significant differences from other populations. Therefore, it appears that the New Zealand populations are nothing more than a segregate of notoscriptus whose larger size and color differences may be associated with the colder environment in New Zealand.

Graham (1939:212) reported notoscriptus "having been more than once taken alive on vessels on their arrival at Auckland from Sydney" and, on this basis and the apparent occurrence of this species only around Auckland, Nelson and Whangarei at that time, considered it to be a recent introduction to New Zealand. I have not been able to locate any of the specimens recovered from ships but there is no reason to doubt that *notoscriptus* was the species reported by Graham. Although at the present time the known distribution of *notoscriptus* in New Zealand is greater than in Graham's time it is still entirely restricted to the vicinity of present day or former seaports. Unlike *Culex quinquefasciatus*, the other introduction to New Zealand, *notoscriptus* is not confined to man-made habitats and has invaded nearly all the other habitats available in New Zealand similar to those it has been reported to utilize elsewhere. Although this circumstantial evidence is not unequivocal, it is highly suggestive that *notoscriptus* is indeed an introduced species in New Zealand.

BIONOMICS. During our survey, the New Zealand population of *notoscriptus* was found to breed largely in various types of large and small artificial containers, wood, metal and cement, but it was also recorded from pools in drying stream beds (NZ 128, 130), rot holes in native trees (NZ 37, 38, 47, 92) and astelia axils (NZ 60, 67). Graham (1929:210) records it in addition from rockholes, fronds of nikau palms (on the palm and on the ground), in banana axils and occasionally in drains, swamps and waterholes. Densely shaded habitats appear to be preferred by this species.

A. notoscriptus is a diurnal biter. It attacks man readily but according to Graham (1929:210) it prefers cattle as a source of blood. Apparently biting activity occurs only in the shade. Graham reports it as a frequent intruder in houses in Auckland but in general it is a sylvan species and is especially abundant in densely wooded gullies. According to Graham (1939:212) *notoscriptus* passes the winter in both adult and larval stages.

DISTRIBUTION (fig. 40). Material examined: 2882 specimens; 126 ♂, 171 ♀, 2176 larvae, 409 pupae; 109 individual rearings (67 larval, 37 pupal, 5 incomplete).

Widely distributed in AUSTRALIA, NEW CALEDONIA, LOYALTY ISLANDS, NEW BRITAIN, NEW IRELAND, NEW GUINEA, and MOLUCCAS.

NEW ZEALAND. *North Auckland*: Opua, 20 Dec 1963, BS (NZ 37, 38), 6 lp♂ (37-102, 104, 105; 38-101, 102, 104), 5 lp♀ (37-103, 106-108; 38-103), 1 lp (37-101), 2 ♀ (37), 1 ♀ (38), 10 L (37), 6 L (38), 1 P (37), 2 P (38) [UCLA]. Whangarei (Graham 1939:212). Dargaville, 12 Dec 1944, G. L. Bissett (494), 1 L [NELS]. Warkworth, 29 Nov 1944, G. L. Bissett (479), 1 L [NELS]. Whenuapai, 31 Oct 1944, G. L. Bissett (441), 1 L [NELS]; 15 Jan 1945, G. L. Bissett (534), 1 L [NELS]. Brown's Bay, 18 Feb 1945, H. Harrison, 1 ♀ [AUCK]. Takapuna, 12 May 1944, A. Sanford (319), 1 L [NELS]. Rangitoto Island, Summit Track, 14 Sept 1963, S (NZ 6), 3 lp♂ (6-101, 109, 111), 1 lp♀ (6-107), 1 p♂ (6-103), 2 p♀ (6-102, 106), 2 lp (6-108, 110), 3 ♀, 13 L, 3 P [UCLA]; gun emplacement, 14 Sept 1963, S (NZ 8), 2 lp♂ (8-109, 112), 4 lp♀ (8-110, 111, 113, 114), 1 p♂ (8-101), 4 p♀ (8-102-105), 2 ♂, 2 ♀, 12 L, 9 P [UCLA]; lava flow near sea, 4 Jan 1964, S (NZ 67), 1 p♂ (67-112) [UCLA]. Henderson, 8 Nov 1944, G. L. Bissett (458), 1 L [NELS]. Waitakere Ranges, Quarry tributary of Waitakere River, 28 Dec 1963, BF (NZ 59, 60), 1 lp♂ (60-112), 1 ♀ (59) [UCLA]. Bethells Road Swamp, 10 Jan 1965, F (NZ 200A), 1 ♀ [UCLA]. Titirangi, S. Titirangi Road, 11 Jan 1964, BS (NZ 95), 2 lp♂ (95-102, 108), 5 lp♀ (95-101, 104-107), 2 p♂ (95-109, 110), 1 lp (95-103), 6 ♂, 5 ♀, 68 L, 20 P [UCLA]. Titirangi Beach, end of Mahoe Road, 30 Dec 1963, BF (NZ 61A, 61B, 63), 2 lp♂ (63-104, 105), 12 lp♀ (61B-101, 108-114, 116; 63-101-103), 1 lp (61B-115), 8 ♂ (61), 10 ♂ (63), 27 ♀ (61), 2 ♀ (63), 706 L (61), 43 L (63), 35 P (61), 14 P (63) [UCLA]; 11 Jan 1964, BS (NZ 89), 21 ♀ [UCLA]; 11 Jan 1964, BS (NZ 91), 5 lp♀ (91-101-105), 38 ♂, 20 ♀, 336 L, 85 P [UCLA]; 11 Jan 1964, BS (NZ 92), 1 lp♀ (92-120) [UCLA]; Mahoe Road, 4 July 1964, F, 1 ♂ (NZ 191A), 3 L (NZ 191B) [UCLA]. Laingholm, 10 Jan 1946, G. L. Bissett (833), 2 L [NELS]. Auckland, 1 L (455), 9 Jan 1945, G. L. Bissett (518), 1 L [NELS]; Avondale, June 1950, H. Harrison, 3 ♀ [AUCK]; Methuen Road, 9 Aug 1964, F (NZ 194), 3 lp♂ (194-126-128), 2 p♂ (194-125, 130), 1 p♀ (194-129) [UCLA]; Grafton, 18 July 1918, D. Miller, 1 ♂, 1 ♀ [BMNH]; Greenlane, 6 Sept 1948, K. P. Lamb, 1 ♀ [AUCK]; Mt. Eden, 16 Apr 1944, E. M. Armstrong (248), 1 L [NELS]; Remuera, 4 Feb 1946, G. L. Bissett (869), 1 L [NELS]. Mangere, 3 Feb 1950, K. P. Lamb, 1 ♀ [AUCK]. Localities uncertain: Broughton Rd, 24 Mar 1919, D. Miller, 1 ♀ [BMNH]; St. Mary's Bay, 24 Mar 1919, D. Miller, 1 ♂, 2 ♀ [BMNH]; Glenalvon, 20 Mar 1919, D. Miller, "in banana palm," 2 ♀ [BMNH].

Little Barrier Island: Small stream between Te Waikahere and Tirikikawa streams, 6 Mar 1964, S (NZ 128), 4 lp♂ (128-106, 108, 110, 121), 4 lp♀ (128-114, 116, 125, 126), 6 p♂ (128-107, 109, 111, 113, 119, 123), 7 p♀ (128-103-105, 112, 117, 122, 124), 7 ♂, 29 ♀, 155 L, 70 P [UCLA]. Near chicken house, 6 Mar 1964, S (NZ 129), 1 lp♀ (129-106), 4 p♂ (129-115, 119, 121, 123), 5 p♀ (129-101, 105, 107, 118, 120), 5 ♂, 6 ♀, 39 L, 36 P [UCLA]. Waipawa stream, 6 Mar 1964, S (NZ 130), 1 P [UCLA].

South Auckland: Coromandel, 26 Apr 1964, N (NZ 222), 15 L [UCLA]. Te Puke, Prew Orchard, 31 Mar 1964, S (NZ 142), 1 ♀, 670 L, 23 P [UCLA].

Gisborne: Waihirere Domain, 25, 26 Dec 1963, BS (NZ 47), 6 lp♂ (47-102-107), 1 p♀ (47-101), 1 ♂, 16 L, 1 P [UCLA].

Nelson: Nelson City (Graham 1939:212).

TRIBE SABETHINI

Genus MAORIGOELDIA

1930. Maorigoeldia Edwards, 1930:302. TYPE SPECIES: *Culex argyropus Walker, 1848, New Zealand; original designation (as subgenus of Rachionotomyia).

23. Maorigoeldia argyropus (Walker)

Figs. 24, 41

1848. Culex argyropus Walker, 1848:2. TYPE: *Holotype ♀, New Zealand; identified as the type by Waterhouse [BMNH].

Maorigoeldia argyropus of Belkin (1962:492-494); Stone (1963:120); Pillai (1965).
Tripteroides (Maorigoeldia) argyropus of Edwards (1932:75); Taylor (1934:11); Lee (1944:17); Stone, Knight and Starcke (1959:65).
Tripteroides (Maorigoeldia) argyropa of Lee (1946:229-230).
Tripteroides argyropus of Miller (1950:45); Miller and Phillipps (1952:27-28).
Rachionotomyia (Maorigoeldia) argyropus of Edwards (1930:302).
Rachionotomyia argyropus of Edwards (1924:360); Graham (1929:227-243; 1939: 213).
Uranotaenia(?) argyropus of Theobald (1901:264-266).

FEMALE (fig. 24; Pillai 1965:fig. 1; Miller and Phillipps 1952:figs. 48-50; Lee 1946:plate XIIa; Graham 1929:figs. 50-56). Wing: 4.25 mm. Proboscis: 2.84 mm. Forefemur: 2.67 mm. Abdomen: about 2.83 mm. As figured here and as described by Belkin (1962:492, 494); with the following diagnostic features. A beautiful large dark mosquito with striking silvery ornamentation with very light bluish tinge as follows: a narrow orbital line on head; a broad dorsal band involving apex of segment 2 and base of segment 3 of the palpus; a broad lateral mesonotal stripe from humeral angle to wing root, interrupted at scutal angle; a narrow continuous line from lower apn diagonally to lower mep; patches on ppl and upper part of pcx, on lower caudal part of stp, and in front of upper mep bristles, not in upper stp as shown by Pillai (loc. cit.); patches on coxae and trochanters; more or less complete postmedian and preapical rings on femora; anterior apical patch on tibiae, largest on hindleg; dorsal patch on apex of segment 3, entire dorsal and anterior surfaces of segment 4 and anterior base of segment 5 on foretarsus; on at least anterior surface from apex of segment 2 distad on midtarsus; from apex of segment 3 distad on hindtarsus; apicolateral patches on abdominal tergites II-VII. Proboscis slightly swollen and recurved in distal third in dry specimens. Palpal segmentation indistinct and variable, segment 1 short and broad, segment 2 long and as broad as 1, segment 3 ankylozed with 2 and narrower and usually longer, a minute apical knoblike segment 4 sometimes present. Spiracular bristles usually 2-4; always at least 1 upper stp bristle. Acrostichals, dorsocentrals, prescutellars and supraalars numerous and strong. All legs with 2 subequal claws; all claws simple and with fine spicules on outer surface.

FEMALE GENITALIA (fig. 24). As figured. Genital segments deeply retracted. Tergite VIII about 0.5 of VII, partially telescoped into latter, sparsely covered with strong bristles distally. Sternite VIII prominent, subequal to tergite, densely covered with heavy bristles except basolaterally where scales are present. No intersegmental sclerotizations between segments VIII and IX. Insula strongly developed and heavily sclerotized, long midventrally, with a few short slender bristles laterally, continuous with sigma which is not joined to cowl. Tergite IX about 0.35 of tergite VIII, moderately sclerotized, with about 3 short heavy bristles near caudal margin on each side of midline. Cowl strongly sclerotized, narrowed laterally, without setae; atrial plate strongly sclerotized ventrally, practically meeting its mate on midline, very lightly sclerotized at its junction with cowl. Tergite X distinctly sclerotized, about 0.4 of tergite IX, without setae. Postgenital plate separated by membrane from cowl, with 2 widely separated lateral bristly lobes. Cercus short, about as broad as wide, with many short bristles except on mesal surface. Spermathecae 3, one very slightly smaller than other 2.

MALE (fig. 24; Graham 1929:fig. 57). As figured here and as described by Belkin (1962:492, 493), essentially as in the female except for sexual differences. Palpal segment 4 present or absent as in the female; antennal whorls much longer and denser than in female, flagellar segments 12 and 13 elongate. Both claws of hindleg present and small; claws of foreleg and midleg enlarged, unequal, simple. Proboscis more distinctly swollen and recurved apically than in female.

MALE GENITALIA (Belkin 1962:fig. 361; Lee 1946:fig. 1; Graham 1929: fig. 58). As figured and described by Belkin (1962:492, 493). Segment IX very strongly developed; tergite with prominent very broad median caudal lobe with a minute median emargination and with very numerous setae in several rows; sternite long and broad. Sidepiece with specialized tergal bristles; basal mesal lobe strongly developed. Clasper simple, curved. Aedeagus complex; broad at base; opisthophallus strongly developed, appearing as a broad lobe dorsad of aedeagus proper (see discussion of male genitalia under Dixinae). Proctiger very broad, paraproct with 2, 3 small apical denticles on the main large tooth; cercal sclerite strongly developed, cercal setae 6-8.

PUPA (Belkin 1962:fig. 361; Graham 1929:figs. 73-75). Abdomen: 3.25 mm. Trumpet: 0.7 mm. Paddle: 0.88 mm. As figured and described by Belkin (1962:492, 493-494) with the following diagnostic features. Trumpet without tracheoid. Paddle produced on apex, without hairs 1, 2-P. Hairs 9-VII, VIII very large, subequal. The following additions to the chaetotaxy figured by Belkin (1962) should be made on the basis of more adequate material. Hair 3-I single, subequal to 12-C; 6-I single, subequal to 3-I; 5-II single, subequal to 7-I but thinner; 1-II usually 4, 5b (3-6); 3-III single, subequal to 3-II; 4-III usually single, subequal to 4-II; 5-III usually single or double (1-4), subequal to 5-II; 1-IV double or triple, subequal to 1-III; 4-IV usually single, subequal to 4-II; 5-IV usually double, subequal to 5-V; 1-V usually single, about 0.75 of tergite VI; 1-VI single, subequal to 3-VII; 3-VI single, subequal to 3-V; 5-VI single, reaching to basal 0.2 of tergite VIII; 1-VII single, a little longer and heavier than 4-VII; 9-VII subequal to 9-VIII but usually with about 10 branches (7-13) instead of 13 (11-17).

LARVA (Belkin 1962:fig. 362; Miller and Phillipps 1953:fig. 51; Lee 1944: plate 4; Graham 1929:figs. 62-72). Head: 1.35 mm. Siphon: 1.2 mm. Anal Saddle: 0.2 mm. As figured and described by Belkin (1962:492, 494), with the following diagnostic features and corrections. A very large larva with light brown head capsule; thorax and abdominal segments 1-IV (V) whitish, (V)VI-VIII yellowish; siphon and anal saddle darker than head capsule; gills sausage-shaped, rounded apically and usually longer than siphon (not as figured by Belkin). Head of very unusual shape (not as figured by Belkin from flattened specimen), distinctly wider than long (1.2), truncate in front and nearly semicircular in outline in back, foramen magnum on ventral surface when viewed flat in a mount. Comb scales in a very large patch. Siphon with distinct pecten and regular paired rows of ventral and subdorsal hairs, mostly double. Anal saddle widely incomplete; saddle hair (1-X) single, about twice length of siphon; ventral brush composed of a single pair of long double hairs.

SYSTEMATICS. M. argyropus is one of the most clearly marked sabethine species in the world. In the full development of the mesonotal bristles in the adults, it has retained the primitive ancestral condition not found in any other Old World sabethine. As I have indicated elsewhere (Belkin 1962:487-488), it is readily separated from all other groups of Old World sabethines in all stages and should be recognized as forming a distinct monotypic genus although it has a number of similarities with members of the genus Tripteroides.

I can find no close relative of argyropus. Tripteroides (Rachionotomyia) tasmaniensis (Strickland, 1911) from Southeast Australia and Tasmania has a pattern of ornamentation of the thorax, legs and abdomen suggestive of argyropus but it differs from the latter in important features of the male and larva. However, I think that argyropus probably represents the earliest offshoot of the same lineage which gave rise to the monotypic tasmaniensis group and the South Pacific caledonicus group of the subgenus Rachionotomyia of Tripteroides.

The most obvious variation I have noted in argyropus is in the segmentation of the palpus in both males and females. There is no indication of geographical differentiation in argyropus.

BIONOMICS. The natural breeding sites of argyropus were unknown until D. A. Schroeder collected this species during our survey in February and March

1964 in rot-holes in Nothofagus trees at Lake Rotoiti, Nelson (NZ 119) and on Little Barrier Island (NZ 133), and Pillai (1965) discovered them in a knot-hole in dead Nothofagus fusca in South Otago in May 1965. Natural breeding sites seem to be uncommon and difficult to locate for collectors but fortunately this interesting species has adapted readily to breeding in just about any kind of artificial receptacle containing water in the vicinity of native forests, including water tanks. One of our collections was made in a drying stream bed pool with leaves on Little Barrier Island (NZ 128). In this collection and 3 others in tins and a tire (NZ 61, 63, 191B), argyropus was associated with Aedes notoscriptus.

Graham (1929:227-243) gives extensive notes on this species, including the description of the egg and oviposition. The egg is said to be ovoid, laid singly on the water surface and to split lengthwise near the ventral surface in eclosion. The larvae have the usual sabethine habit of resting on the bottom of the breeding container with the dorsal surface down. They seldom come to the surface film to obtain air and are very hardy.

All the adults I have seen were collected during the months of December through February. However, young larvae were obtained in July at Titirangi Beach (NZ 191B) in a small tin together with Aedes notoscriptus, females of which were biting at the time. Graham (1929:232) reports "hibernating" argyropus adults under dead nikau and tree fern fronds and in week-end cottages in the Waitakere Ranges. I think, therefore, that at the latitude of Auckland at least, both adults and immature stages survive through the winter and breeding may continue at a slower rate. Pillai (1965:34) implies that in South Otago adults die in the fall after laying eggs towards the end of the autumn and a new crop appears during the spring from the overwintering larvae.

Graham (1929:232) states that argyropus females are persistent biters. This was not our experience in areas of fairly high larval density where we saw a number of adults resting on tree trunks and warily approaching in the typical flying attitude of sabethines but never landing or biting. The relative rarity of the strikingly marked adults of this species in collections also supports the view that argyropus is not readily attracted to man. Pillai (1965:35) notes the absence of this species in mosquito pools for arbovirus studies in areas where the immature stages have been collected.

DISTRIBUTION (fig. 41). Material examined: 409 specimens; 33 ♂, 25 ♀, 325 larvae, 26 pupae; 14 individual rearings (10 larval, 1 pupal, 3 incomplete).

NEW ZEALAND. North Auckland: Waitakeres, 18 Feb 1959, M. Knight, 1 ♀ [AUCK]. Titirangi, 2 Feb 1945, G. L. Bissett (588), 1 L, 2 P [UCLA], 2 L, 1 P [NELS]; locality questionable (557), 4 L [NELS], (605), 1 ♂, 1 ♀ [NELS]. Titirangi Beach, end of Mahoe Road, 30 Dec 1964, BF (NZ 61B), 3 lp♂ (61B-102, 104, 107), 4 lp♀ (61B-105, 106, 117, 118), 2 lp (61B-103, 121), 50 L [UCLA]; same data (NZ 63), 4 ♂, 4 ♀, 17 L [UCLA]; same locality, 11 Jan 1964, BS (NZ 90), 2 ♂ [UCLA]; same locality, 4 July 1964, F (NZ 191B), 16 L [UCLA]. Clevedon, 5 Apr 1964, S (NZ 143), 11 L; same data (NZ 144), 1 p♂ (144-101), 6 ♂, 8 ♀, 134 L, 7 P [UCLA].

Little Barrier Island: Small stream between Te Waikohare and Tirikikawa streams, 6 Mar 1964, S (NZ 128), 24 L [UCLA]. Summit Track, elev. 750 ft, 7 Mar 1964, S (NZ 133), 2 lp♂ (133-101, 104), 1 lp♀ (133-103), 1 lp (133-102), 18 L [UCLA].

Wellington: Ohakune, elev. 2060 ft, Feb 1920, T. R. Harris, 1 ♂ [BMNH]; same elev., 24 Jan 1922, T. R. Harris, 1 ♀ [USNM]; elev. not specified, 15 Dec 1922-15 Jan 1923, T. R. Harris, 3 ♂ [BMNH]; Jan 1924, T. R. Harris, 1 ♂ [BMNH], 1 ♂ [USNM]; Feb 1924, T. R. Harris, 1 ♂ [BMNH]. Wellington, Wilton Bush, Feb 1922, on tree trunks, G. V. Hudson, 1 ♂, 2 ♀ [BMNH]; locality and date not specified, Hutton (118C), 1 ♂ [CANT].

Nelson: Nelson, north branch Maitai River, elev. ca 400 ft, 11 Feb 1964, S (NZ 123A), 1 ♂ [UCLA]. Aniseed Valley, 1-4 Dec 1923, A. L. Tonnoir, 4 ♂ [NELS], 1 ♂ [CANT]. Lake Rotoiti, 9 Feb 1964, S (NZ 119), 29 L [UCLA].

Marlborough: Goose Bay, 4 Feb 1925, A. L. Tonnoir, 1 ♂ [CANT].

Canterbury: Price's Bush, Banks Peninsula, 2 Dec 1934, S. Lindsay, 1 ♂, 1 ♀ [CANT].

Westland: Whataroa, Scenic Reserve, July 1964, L (Pillai 1966). Okarito Lagoon, June 1965, L (Pillai 1966).

Otago: Southeastern coast, lat. 46°35'S, May-Sept 1965, L (Pillai 1966).

New Zealand, locality not specified: Holotype ♀ [BMNH]; 1 ♀ [WELL].

SUBFAMILY CHAOBORINAE

The Phantom Midges

The phantom midges and related forms are readily recognized from true mosquitoes and dixa midges by the characters given in the keys to subfamily. The general features of the Chaoborinae have been reviewed by Belkin (1962: 535-537). The phallosome in this subfamily is very simple, consisting of a poorly developed basal piece and a pair of aedeagal sclerites articulating directly with it, without a distinct intermediate paramere. Apparently no aedeagal pouch is ever developed in this group and the aedeagus is therefore erect at rest and not retracted.

The Chaoborinae are all predaceous in the larval stage. They are best represented on large continental areas, especially in the Holarctic region, but the tribes Corethrellini and Chaoborini are known from relatively small islands. To date, the very primitive Corethrella novaezealandiae, for which a new subgenus is here recognized, is the only representative of the subfamily reported from New Zealand. It is surprising that no member of the tribe Chaoborini has been found in New Zealand. It is quite possible that this tribe is also represented but has been overlooked in New Zealand because of the midgelike appearance of the adults of the smaller species and the specialized breeding sites of the immature stages. A thorough survey for Chaoborus-like forms should be made with light traps for adults and dredging nets for immature stages in lakes and ponds.

TRIBE CORETHRELLINI

Genus CORETHRELLA

1902. Corethrella Coquillett, 1902:191. TYPE SPECIES: *Corethra brakeleyi Coquillett, 1902, New Jersey, U. S. A.; original designation.
1911. Ramcia Annandale, 1911:187. TYPE SPECIES: *Ramcia inepta Annandale, 1911, Ceylon; monobasic.
1942. Lutzomiops Lane, 1942:127. TYPE SPECIES: Corethrella nigra Lane, 1939, Brazil; original designation.

Notocorethrella Belkin, n. subg.

TYPE SPECIES: Corethrella novaezealandiae Tonnoir, 1927.

ADULTS. Vestiture of body and legs entirely of hairs and bristles, no distinct scales developed; bristles moderate in length. Pleural bristles on upper and lower apn, upper ppn and upper mep. Claws all toothed in the male, probably also in female (not noted). Vein R_1 ending on C well beyond furcation of R_{2+3}, distance between apex of R_2 and R_1 only slightly more than that between apex of Sc and R_1; Rs only slightly longer than crossvein r-m; vein M beyond crossvein m-cu only slightly shorter than vein M_{1+2}; base of Cu_1 forming an angle of more than 60° with base of Cu_2. Vestiture of all wing veins except C entirely of long hairs without any indication of striations; vein C and fringe with flat broad striated scales in addition to hairs.

MALE GENITALIA. Sidepiece without specialized thickened bristles near base but with several thickened short bristles on mesal and sternomesal surface distally. Clasper distinctly shorter than sidepiece, broad, strongly expanded in distal half; with a distinct short, heavy spiniform and several minute setae near apex; long mesal seta submedian in position. Ninth tergite very large.

24. Corethrella (Notocorethrella) novaezealandiae Tonnoir

Figs. 3, 42

1927. Corethrella novae-zealandiae Tonnoir, 1927:107-108. TYPE: *Holotype ♀, Otira (Westland), New Zealand, 7 Feb 1922, A. L. Tonnoir [NELS].

Corethrella novaezealandiae of Edwards (1932:19); Taylor (1934:8); Miller (1950:43); Belkin (1962:540).

FEMALE (Tonnoir 1927:fig. 2; Belkin 1962:fig. 404). Wing: 2.5 mm. Entire body: 2.0 mm. As described by Tonnoir and Belkin, with the characters of the subgenus and the following diagnostic features. General coloration dark yellowish; body and legs with hairs only. Wing slightly yellowish and with infuscations at the crossveins, furcations, in cell C and in apex of cell Sc; veins with golden hairs; fringe metallic pale golden.

MALE (fig. 3). As figured; essentially as in the female except for antennal and leg characters; additional morphological details described from slide mounts are probably applicable to both sexes; bristles of mesonotum probably longer than figured from slide-mounted specimen. Antennal scape smaller than in female, with 2, 3 bristles; torus enlarged; bristles of basal flagellar whorls longer but not very numerous (about 8); proportions of flagellar segments as figured. Palpus distinctly 5-segmented, all segments with setae; segments 1 and 2 short, 2 a little longer, segment 3 about 2.5 of 2, segment 4 about 1.3 of 2, segment 5 a little longer than 3. Upper part of apn with about 5 short thickened bristles, lower part with about 4 longer thinner bristles; upper mep with 1 long and 1 short bristle; metanotum with 3 bristles on each side. Legs apparently with only a few extremely long hairs which are usually developed in most species of Corethrella in greater number and larger size on the femora, tibiae and first tarsal segments. Claws of foreleg and midleg greatly enlarged, distinctly longer than tarsal segment 5, strongly recurved, members of a pair not markedly different in size but mesothoracic longer than prothoracic; all with a slender sharp ventral tooth in basal half but without outer spicules; anterior claw on both legs with a long slender spine projecting outward from near base (probably homolog of outer spicules); hindclaws much smaller, subequal in size, with a short sharp ventral submedian tooth, anterior claw with a short curved spine projecting from outer surface; probably hindclaws similar to those of female. Wing venation and vestiture as figured; probably scales on vein C more numerous than shown but fringe appears to be much less developed than usual in other species. Abdomen with minute spiracles on segments II-VII.

MALE GENITALIA (fig. 3). As figured and with the diagnostic features indicated for subgenus. Tergite IX very large, with numerous setae some of which project beyond apex of sidepiece. Sidepiece with long bristles laterally and ventrally toward apex; base of dorsal surface without conspicuous setae; middle of tergomesal area with 6-8 slender setae, followed ventrodistad by 3 thickened longer straight setae; distal sternomesal margin with 2 or 3 similar but stronger setae with more prominent basal tubercles. Clasper short, broad and further expanded in distal two-thirds in dorsal plane; a large seta near the inner sternal margin at about 0.45 from base; a distinct short heavy spiniform near sternal end of broad apex, followed dorsad by a line of about 6 minute setae. Aedeagus (penis valves) bulbous at base, slender and only slightly tapering in distal half beyond the neck.

IMMATURE STAGES. Unknown.

SYSTEMATICS. *C. novaezealandiae* is the only representative of the subfamily found to date in New Zealand. In common with other culicids of New Zealand it appears to have retained several important primitive features of its phyletic line, notably the following: (1) vestiture of the body, legs and wing veins other than C entirely of bristles and hairs, without any indication of flattening or striations, (2) ends of veins Sc and R_1 on costa widely separated, (3) fringe of wing relatively poorly developed, (4) sidepiece of male genitalia without marked specializations, (5) clasper relatively short and with a well developed spiniform, and (6) tergite IX very strongly developed in the male. Since this combination of features separates *novaezealandiae* very distinctly from all other species of *Corethrella* known to me, I am proposing a new subgenus for this unique form. Should the immature stages of *novaezealandiae* prove to be as distinctive as its adults, *Notocorethrella* may have to be raised to full generic rank.

BIONOMICS. This species probably breeds in the grassy margins of lakes and ponds as do many other species of *Corethrella*. To date only 2 males and 4 females have been collected, all in Westland. The 2 males were taken in a landing-biting collection on the shore of Lake Mapourika just after dark.

DISTRIBUTION (fig. 42). Material examined: 2 ♂, 4 ♀. NEW ZEALAND. *Westland*: Lake Brunner, 2 Feb 1922, A. L. Tonnoir, 1 ♀ [NELS]. Otira, 7 Feb 1922, A. L. Tonnoir, ♀ holotype [NELS]. Lake Mapourika, 6 Feb 1964, S (NZ 112), 1 ♂ (112-1) [NELS], 1 ♂ (112-2) [UCLA]. Waiho, 30 Jan 1922, A. L. Tonnoir, 1 ♀ [NELS], 1 ♀ [BMNH].

RECORDS OF EXTRALIMITAL SPECIES

Graham (1939) reported the following extralimital nominal species from North Auckland. I have not seen any of the material on which these records are based and no additional records of any of these forms have been reported.

Anopheles maculipennis Meigen, 1818 was identified by Graham (1939:213) on the basis of 1 live female taken at Auckland on a ship from the East Indies on 27 May 1929 and another female taken on 4 Sept 1929 on a ship from Samarang. This is obviously a misidentification as the *maculipennis* complex is not represented in the East Indies. There is no way of determining the actual species seen by Graham.

Culex annulirostris Skuse, 1889 was discovered by Graham (1939:111) breeding in the hold of S. S. Tofua on arrival at Auckland from Suva and subsequently breeding in a barrel on the waterfront. This is a plausible identification as this species may be dispersed in boats and possibly ships in the tropical South Pacific. However, Graham's identifications of immature stages are not reliable and it is possible that the larvae were actually *pervigilans*.

Aedes vexans (Meigen, 1830) was identified by Graham (1939:213) on the basis of a single collection of larvae found "in a tin of water jammed among rocks just above high tide at Russell in July, 1929." I think it is very likely that the species involved was *Aedes (F.) notoscriptus* which is known from this general area, utilizes containers for breeding and tolerates a fair degree of salinity (collections NZ 37, 38).

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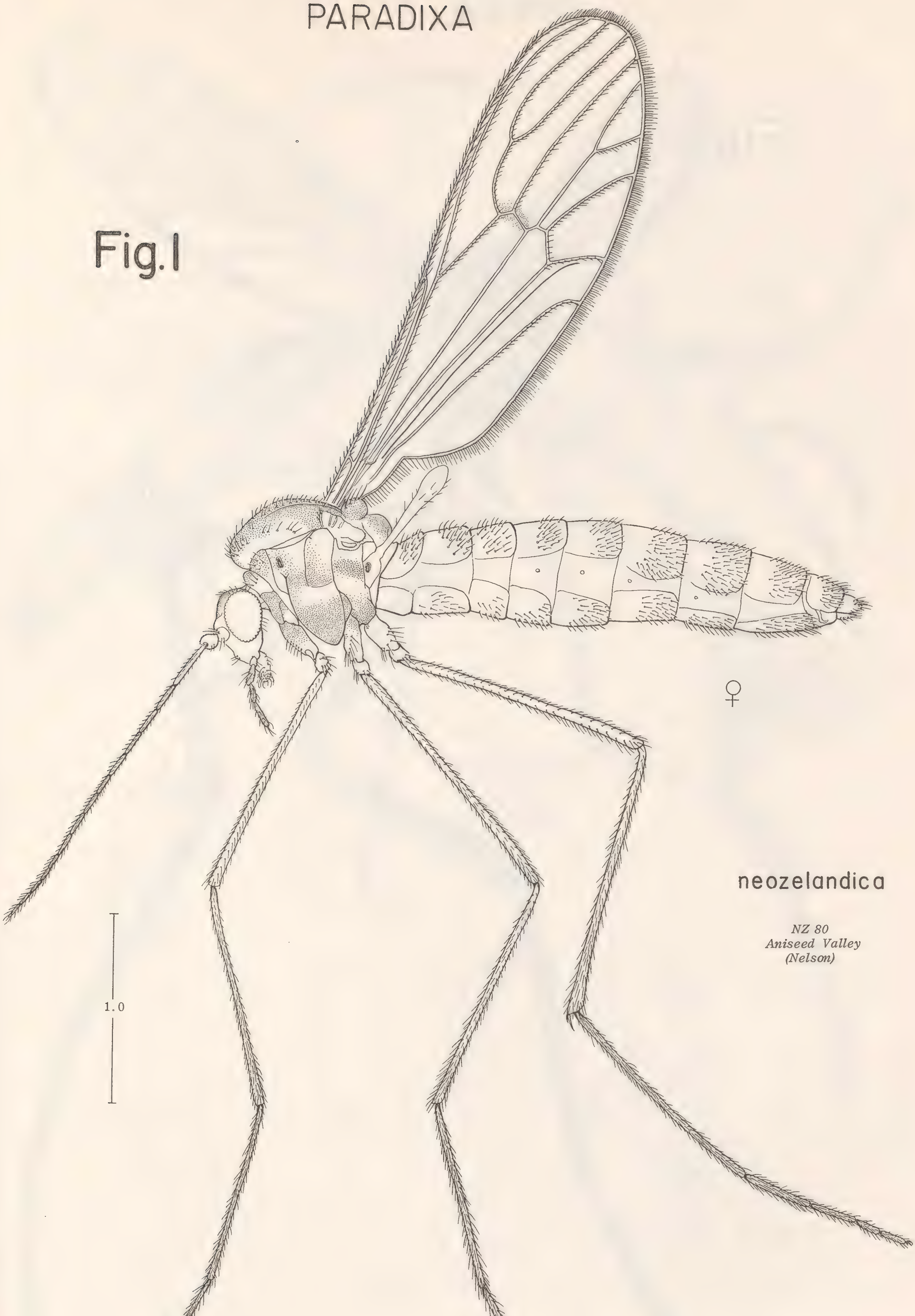
FIGURES

PARADIXA

Fig.1

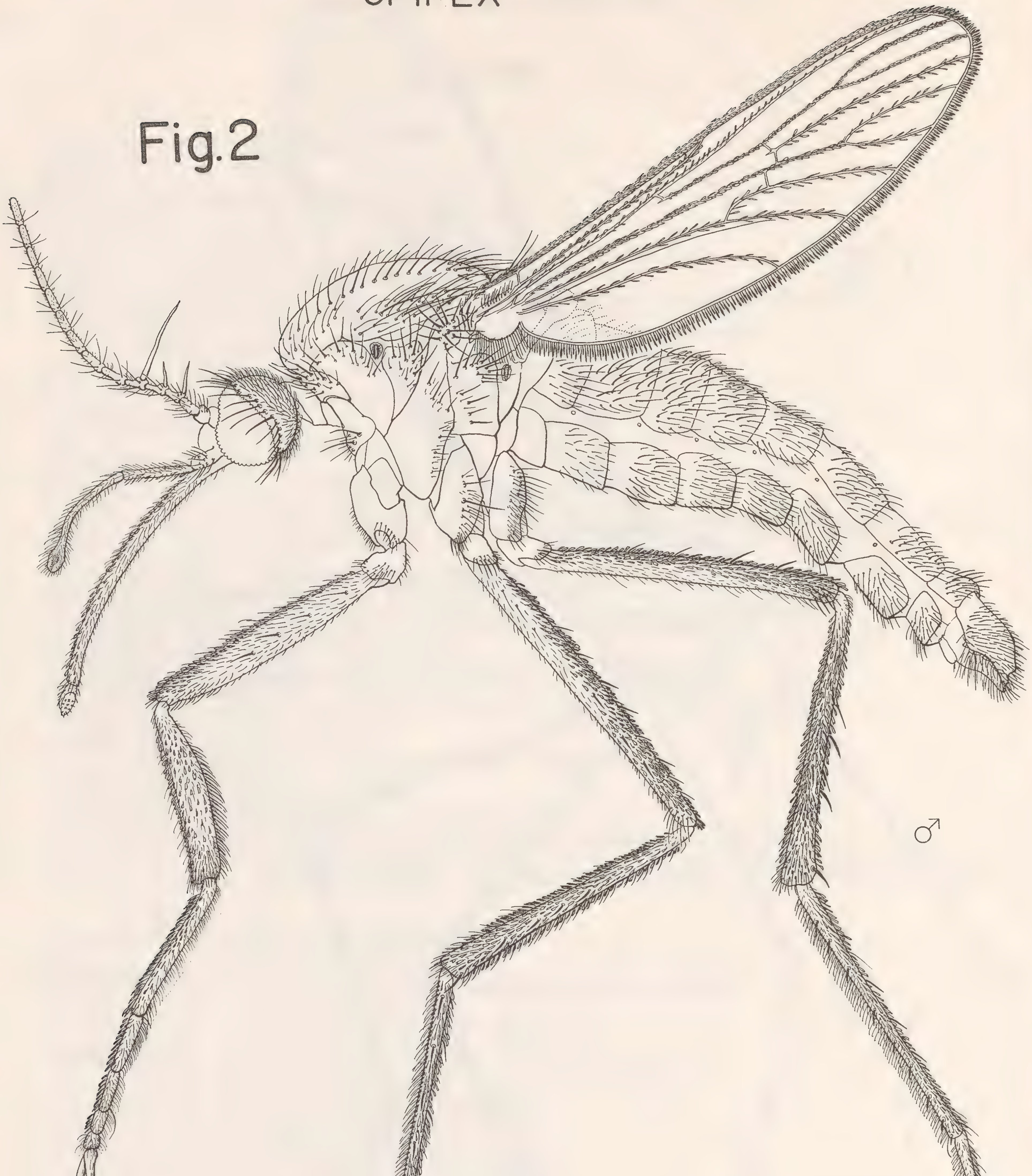


neozelandica

NZ 80
Aniseed Valley
(Nelson)

OPIFEX

Fig.2

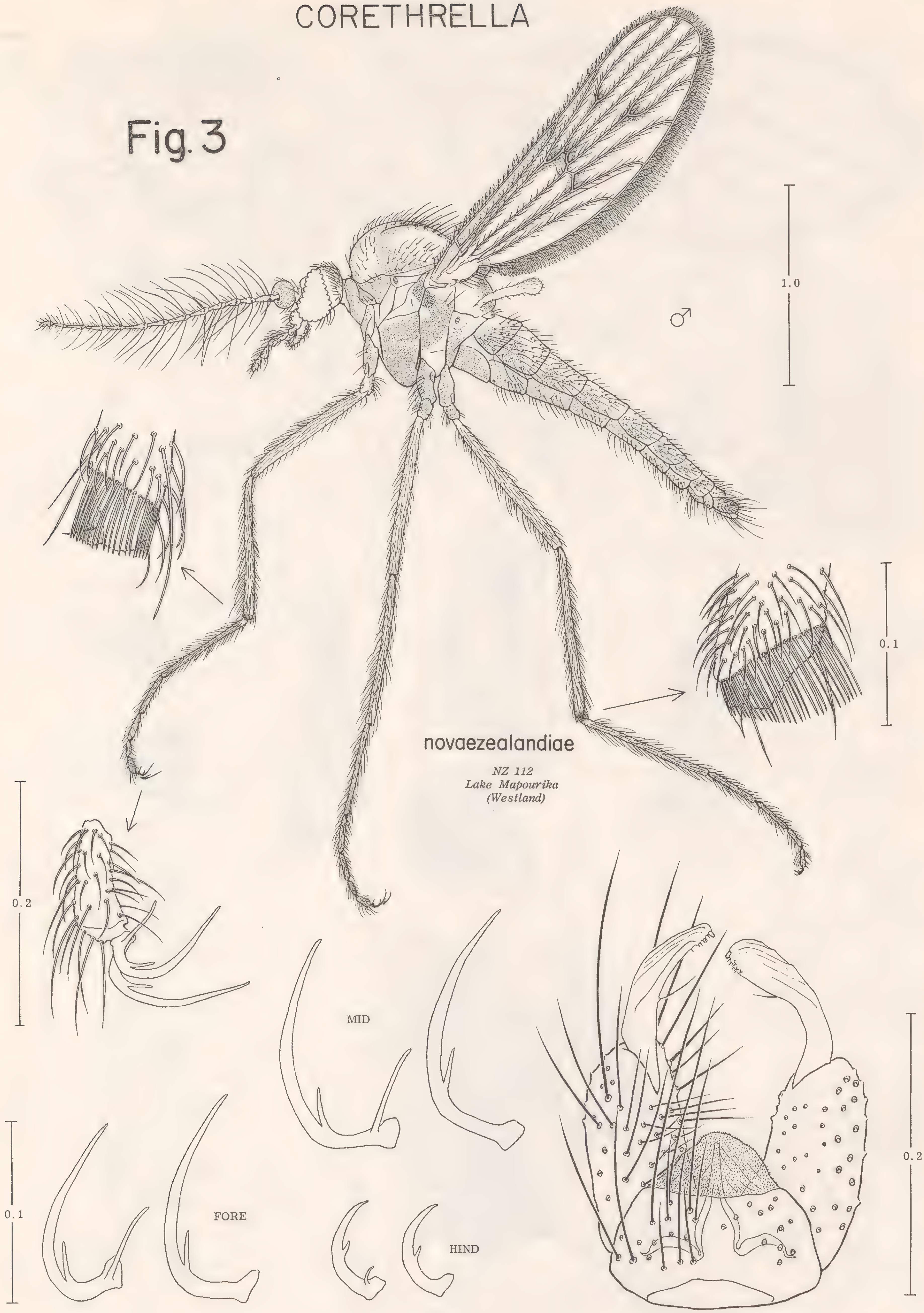


fuscus

Island Bay
Wellington

CORETHRELLA

Fig. 3



novaezealandiae

NZ 112
Lake Mapourika
(Westland)

NOTHODIXA

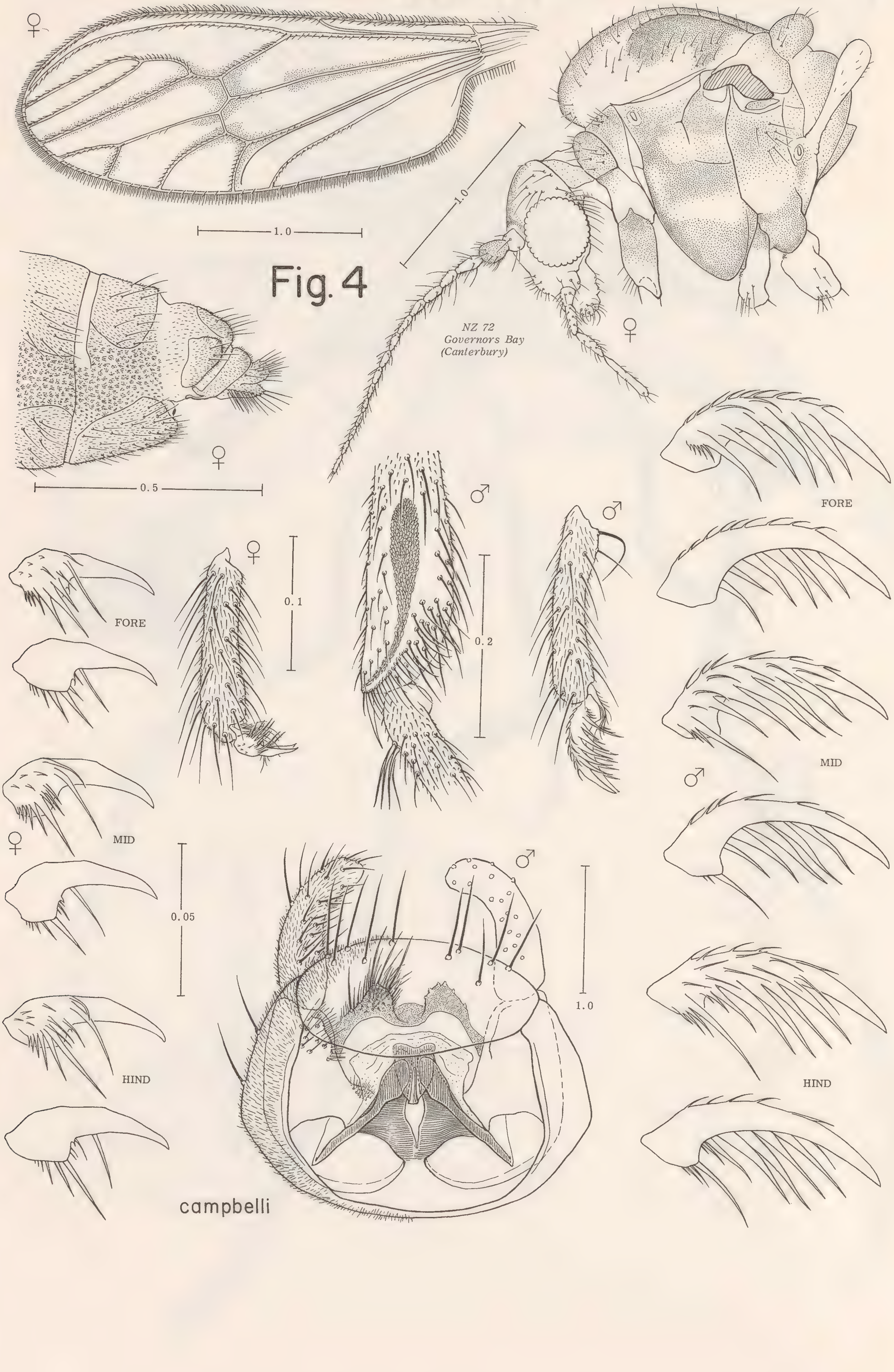


Fig. 4

campbelli

NOTHODIXA

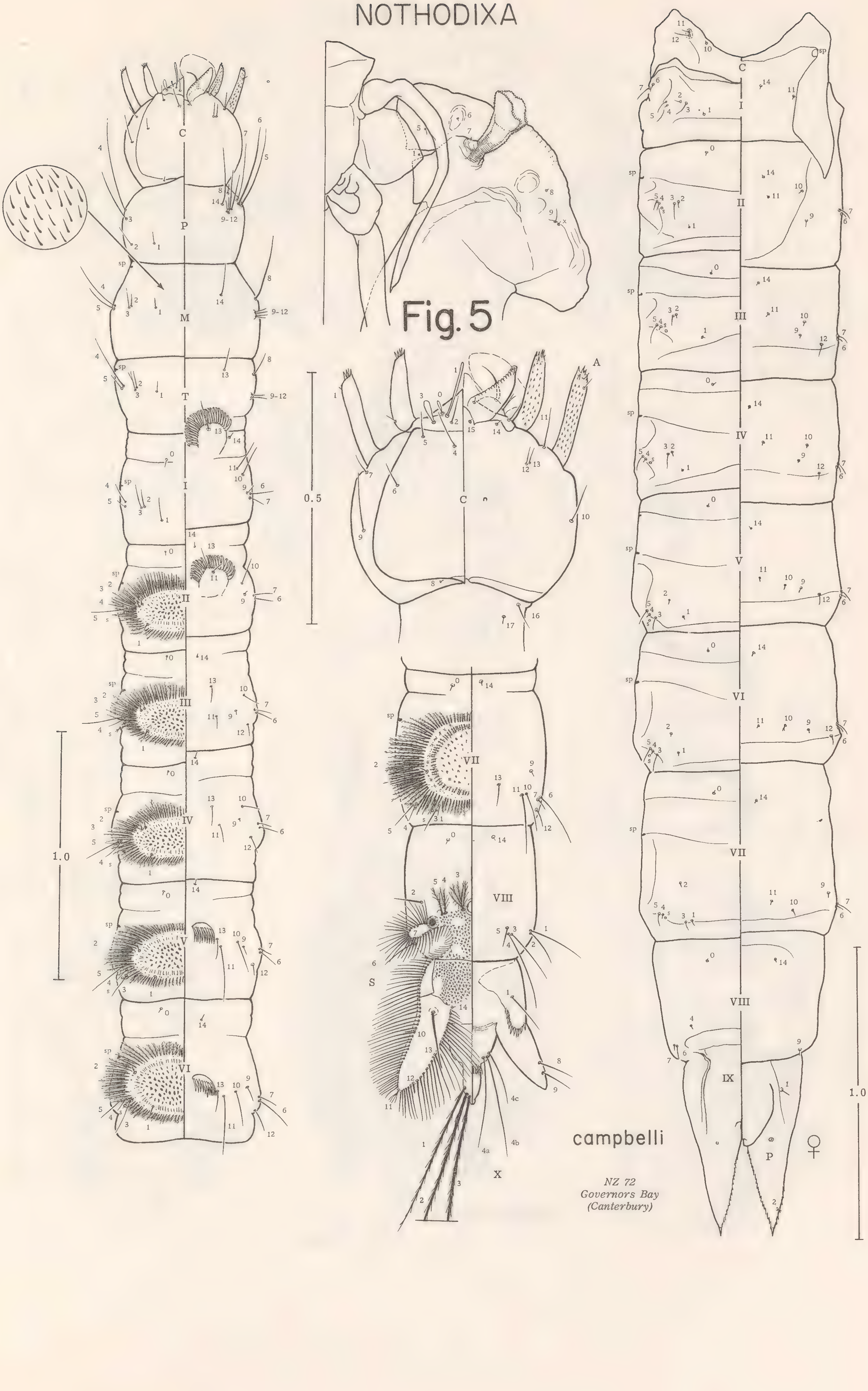


Fig. 5

campbelli

NZ 72
Governors Bay
(Canterbury)

NOTHODIXA

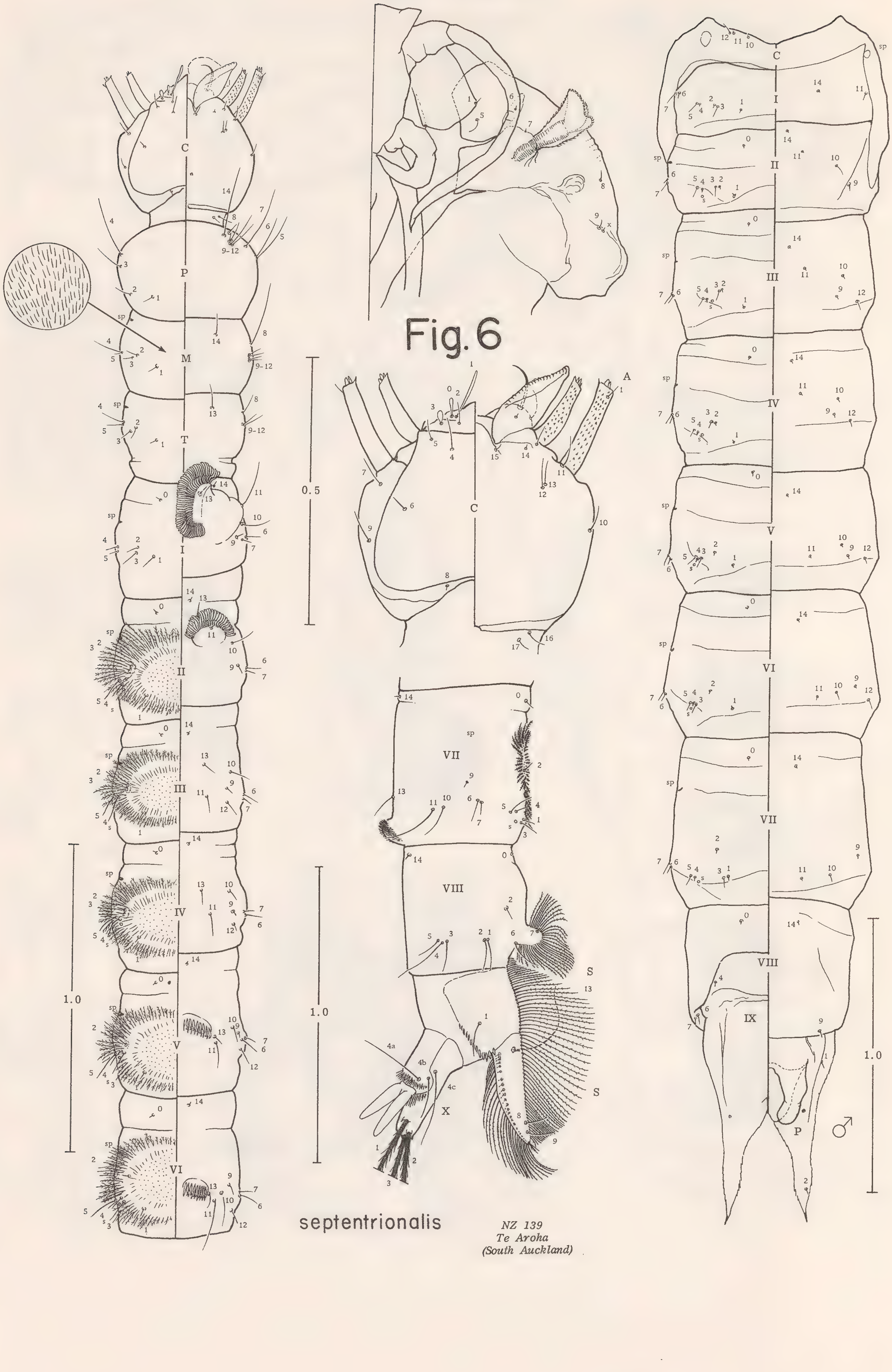


Fig. 6

septentrionalis

NZ 139
Te Aroha
(South Auckland)

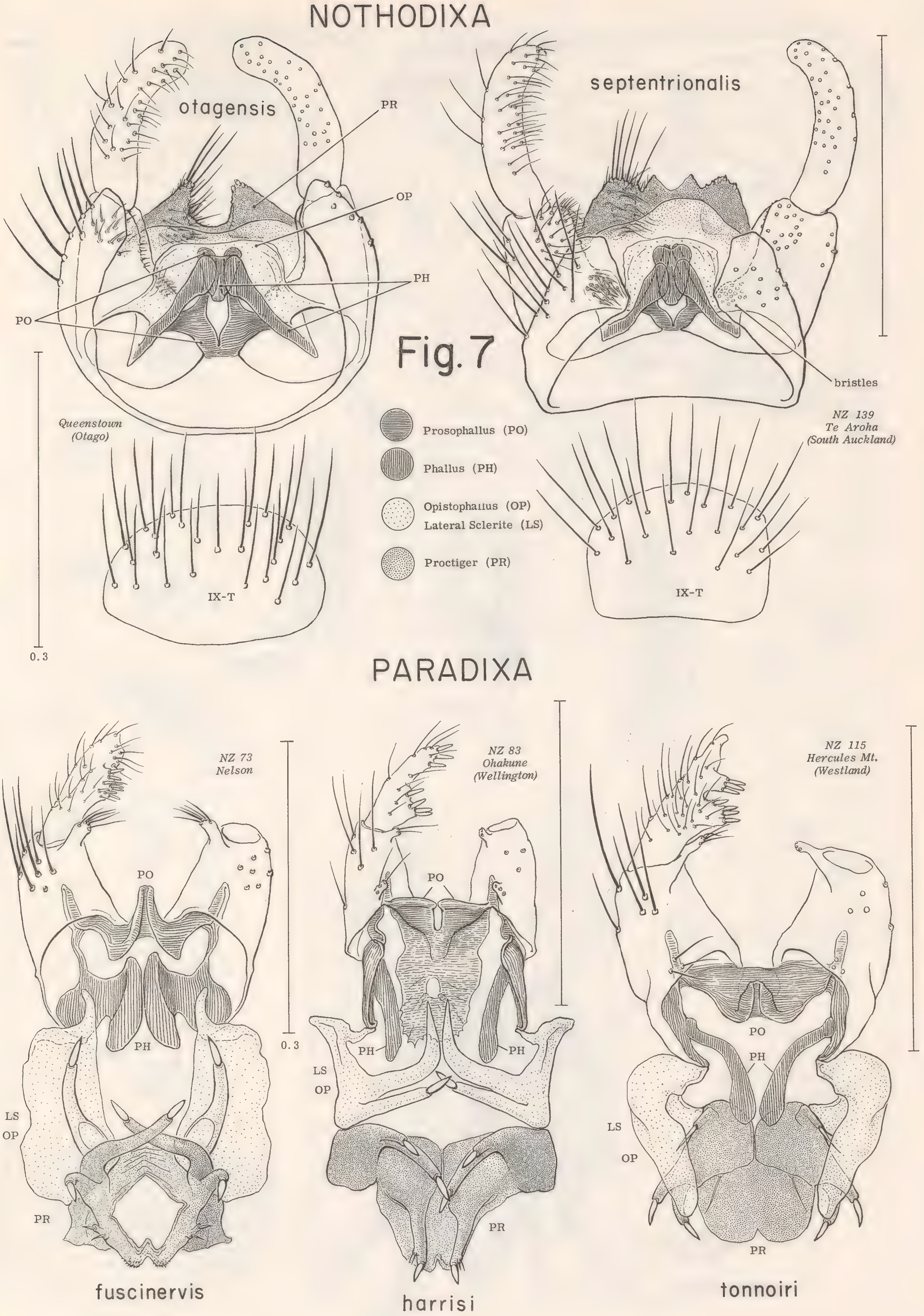


Fig. 7

NOTHODIXA
otagensis
septentrionalis
PR
OP
PH
PO
bristles
Queenstown
(Otago)
NZ 139
Te Aroha
(South Auckland)
Prosophallus (PO)
Phallus (PH)
Opistophallus (OP)
Lateral Sclerite (LS)
Proctiger (PR)
IX-T
IX-T
0.3
PARADIXA
NZ 73
Nelson
NZ 83
Ohakune
(Wellington)
NZ 115
Hercules Mt.
(Westland)
PO
PH
LS
OP
PR
0.3
PO
PH
PH
LS
OP
PR
PO
PH
LS
OP
PR
fuscinervis
harrisi
tonnoiri

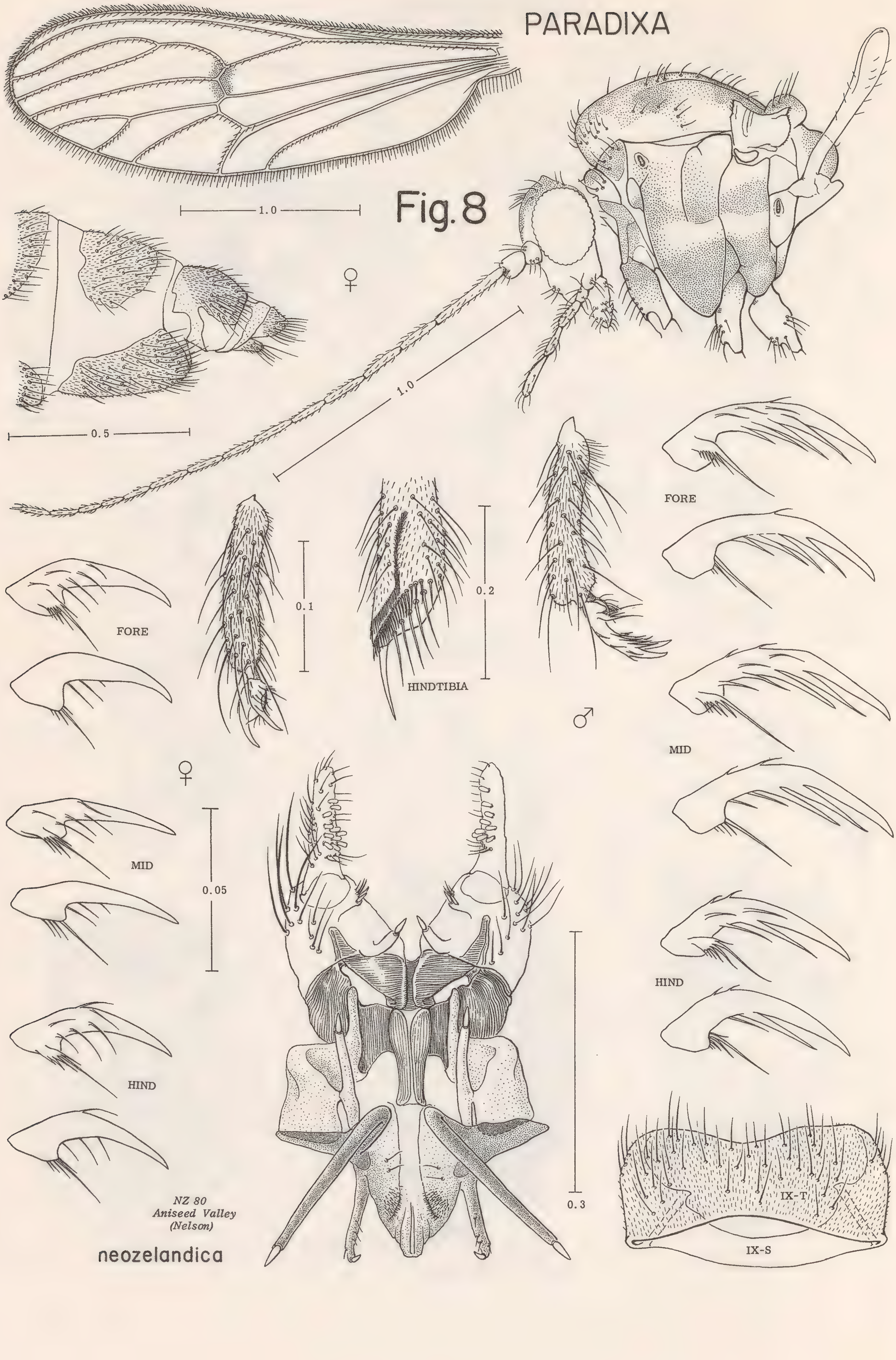
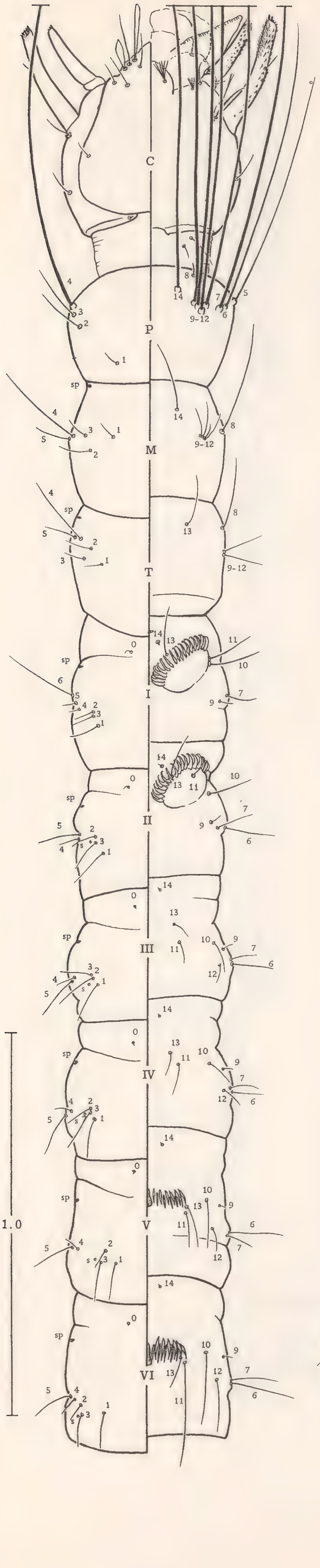


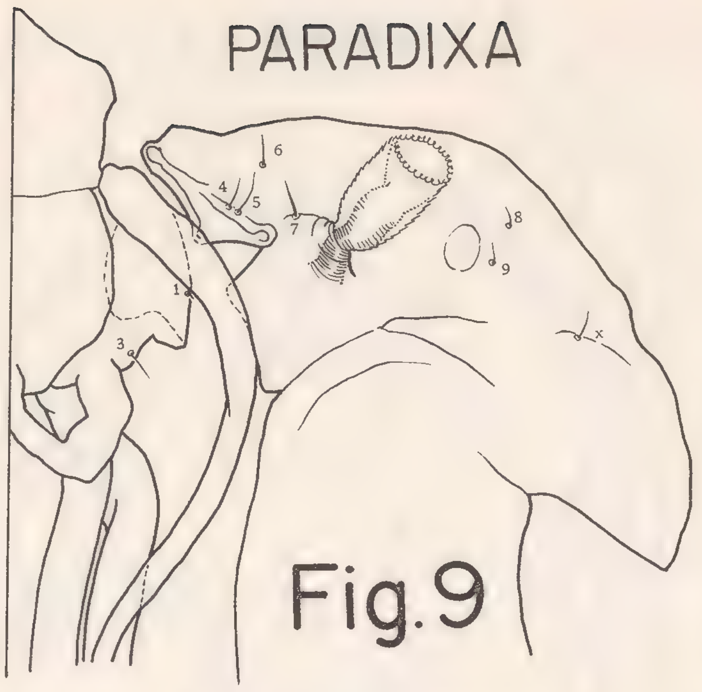
Fig. 8

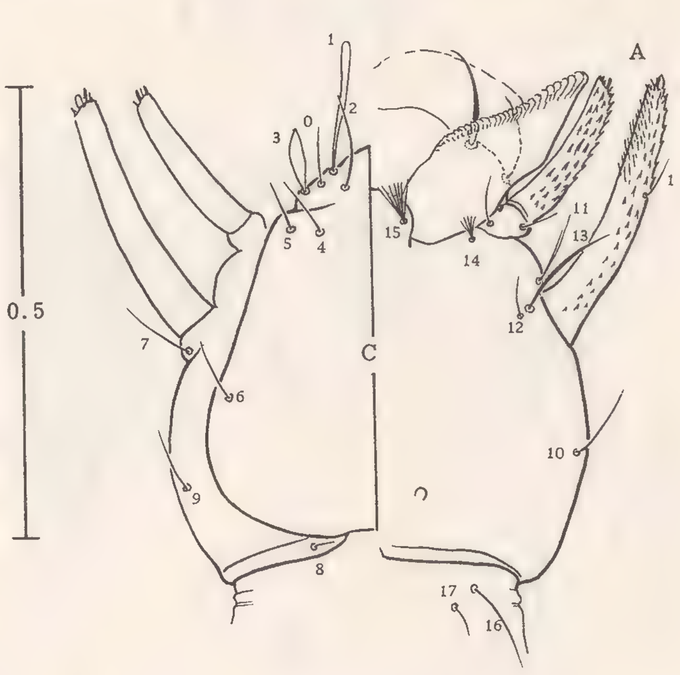
PARADIXA
1.0
♀
0.5
1.0
FORE
0.1
HINDTIBIA
0.2
FORE
MID
♂
♀
MID
0.05
HIND
HIND
0.3
IX-T
IX-S
NZ 80
Aniseed Valley
(Nelson)
neozelandica

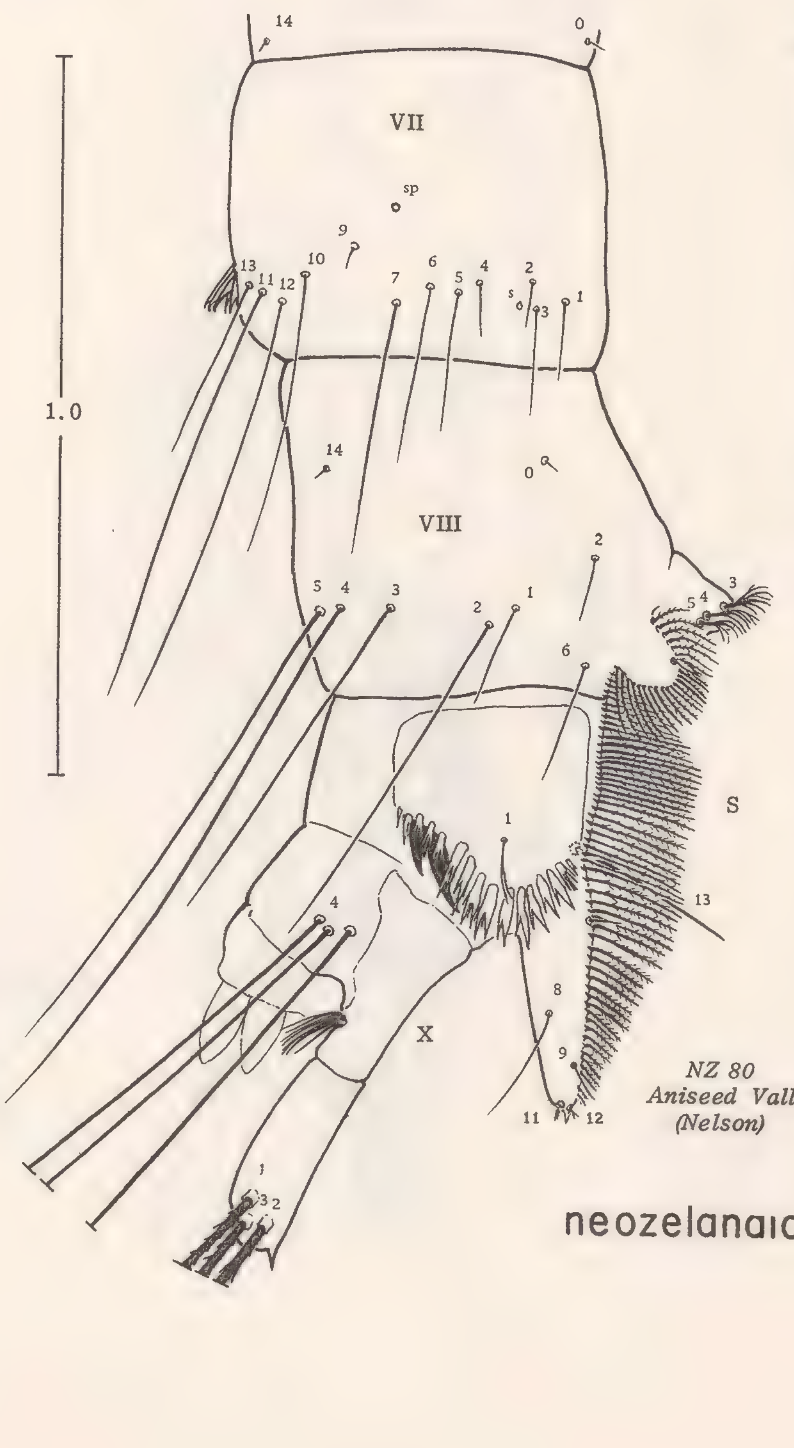
PARADIXA

Fig.9

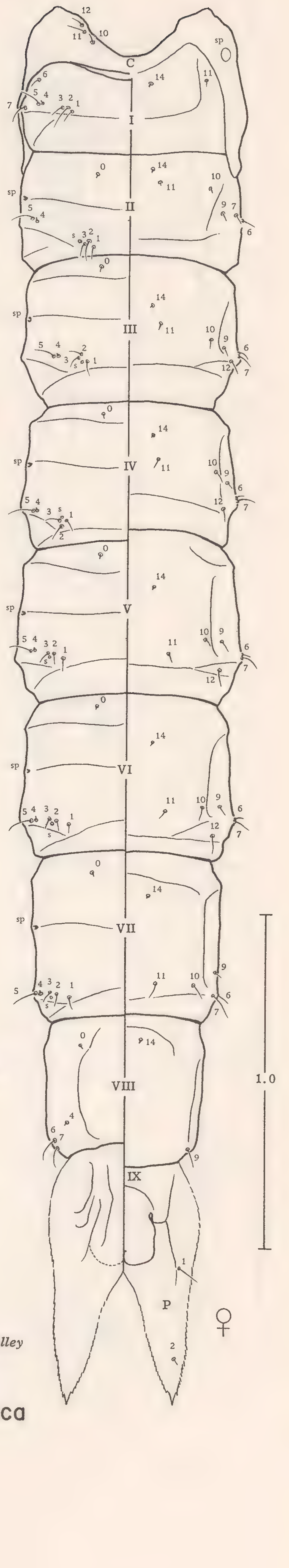








NZ 80
Aniseed Valley
(Nelson)



neozelanaica

PARADIXA

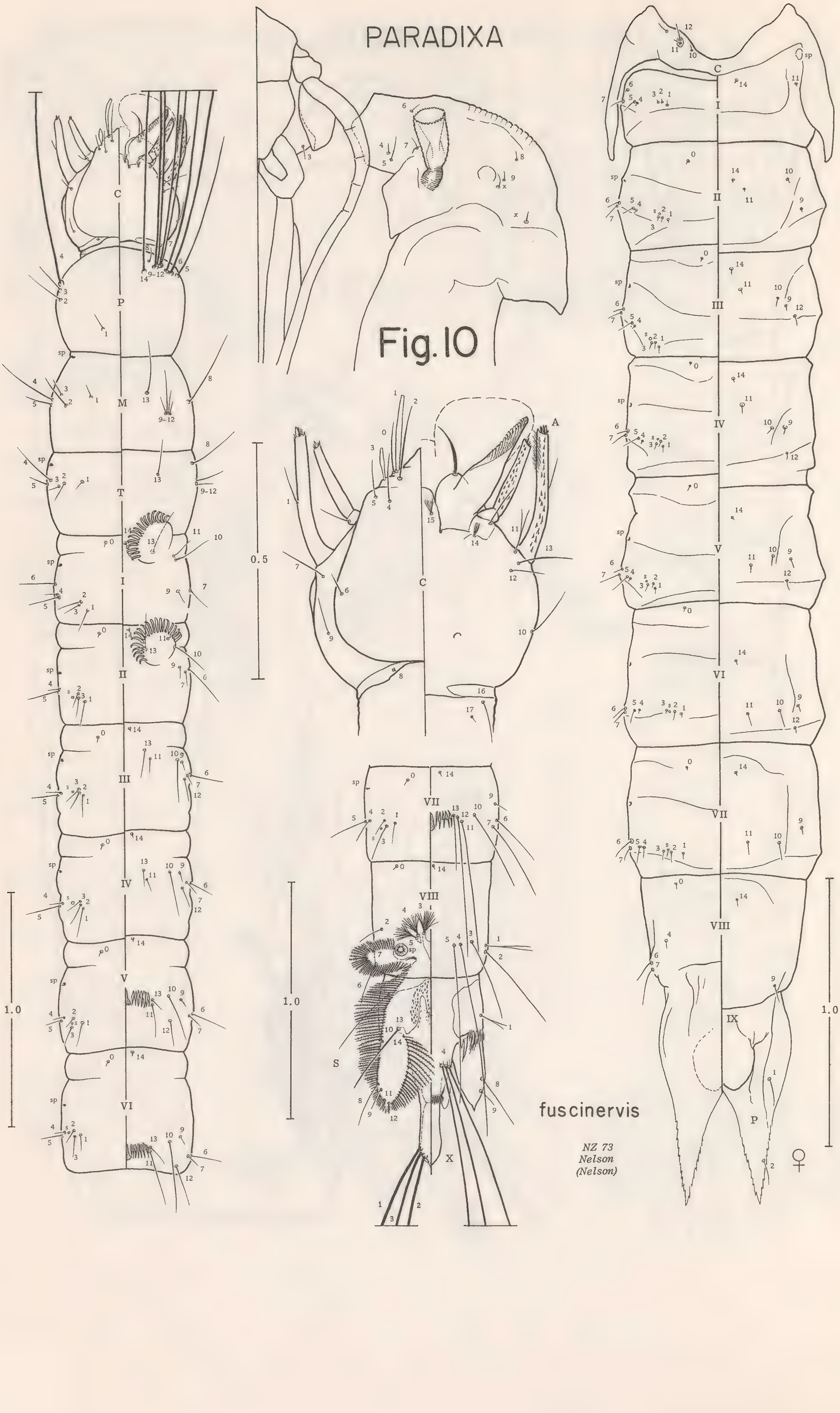


Fig. 10

fuscinervis

NZ 73
Nelson
(Nelson)

♀

PARADIXA

Fig.11

tonnoiri

NZ 115
Hercules Mountain
(Westland)

PARADIXA

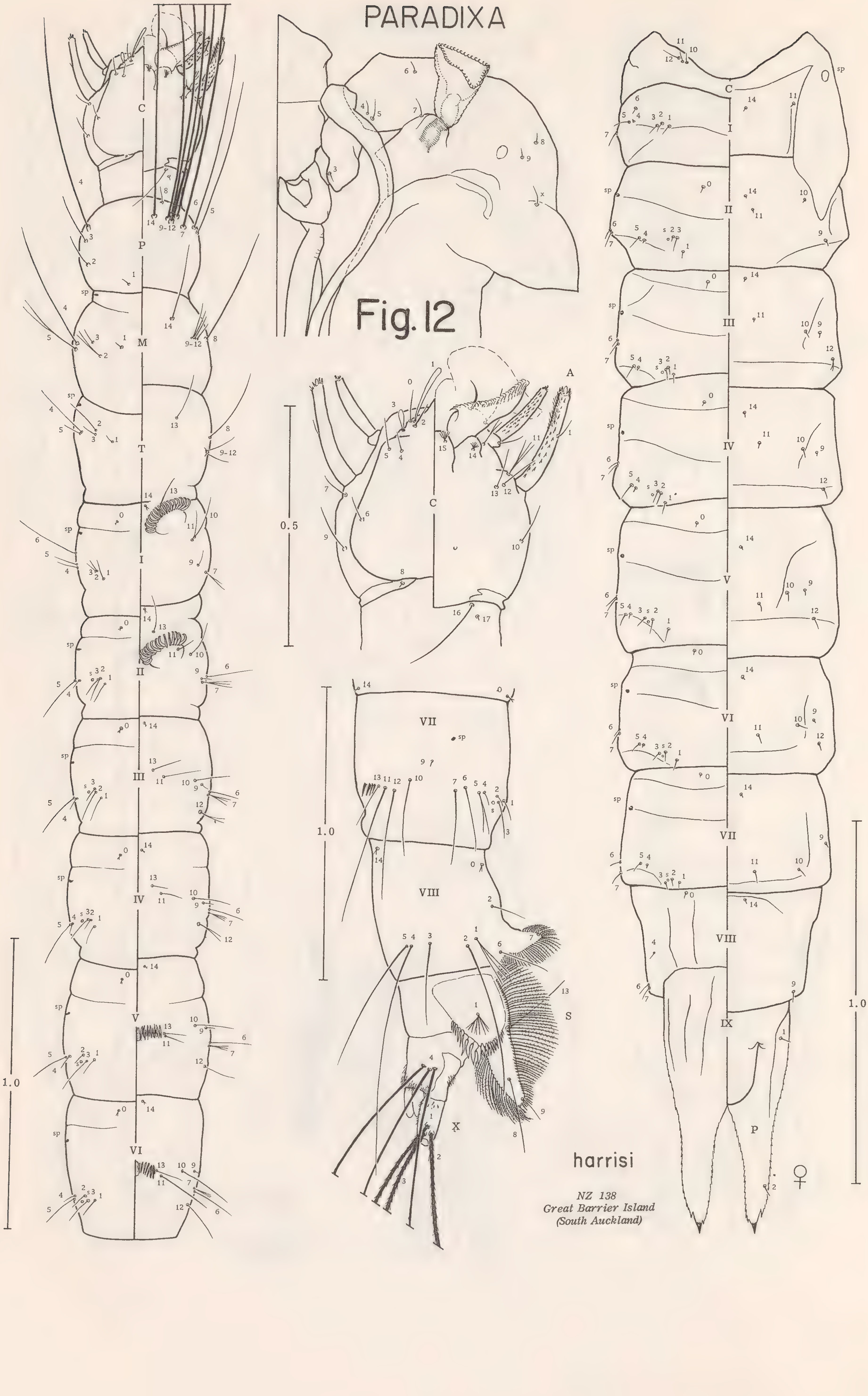


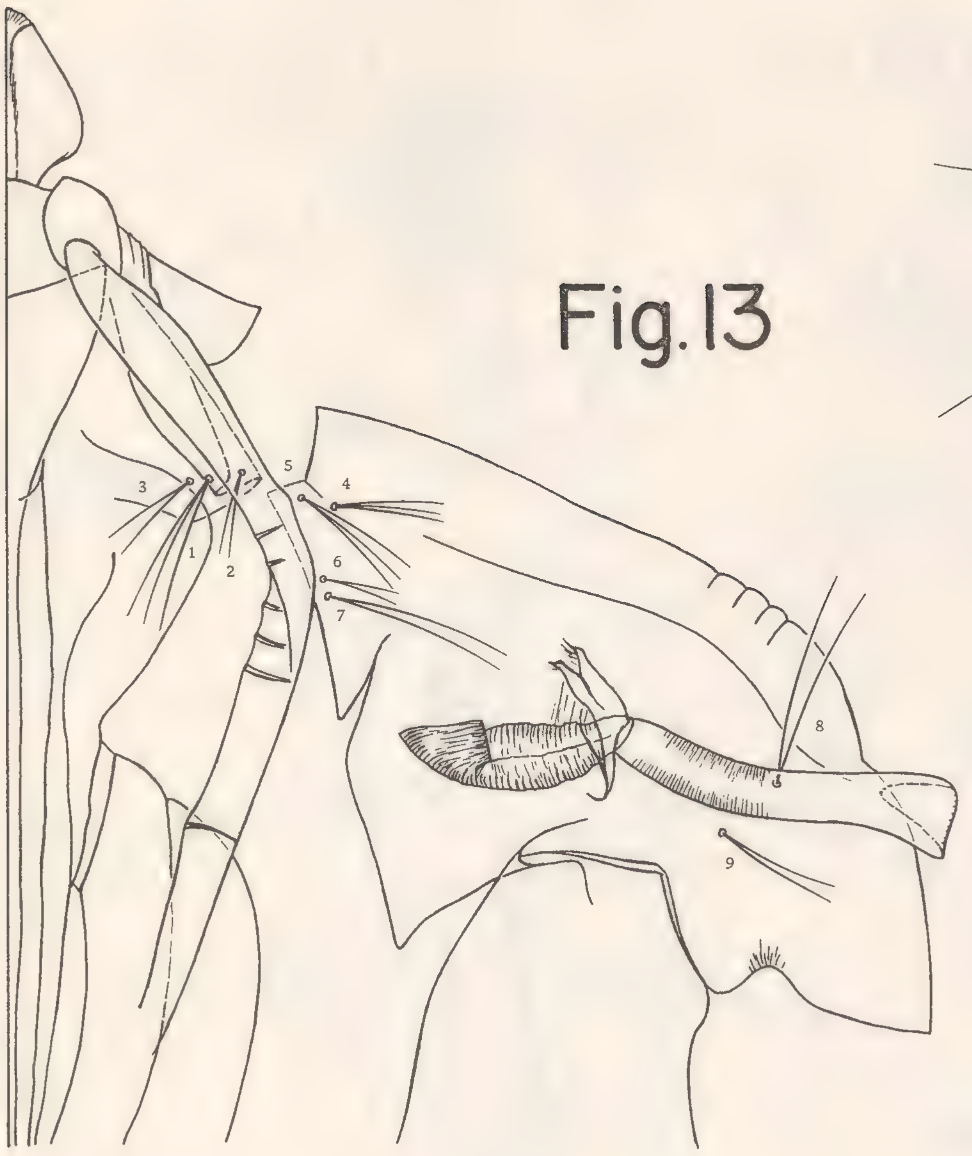
Fig. 12

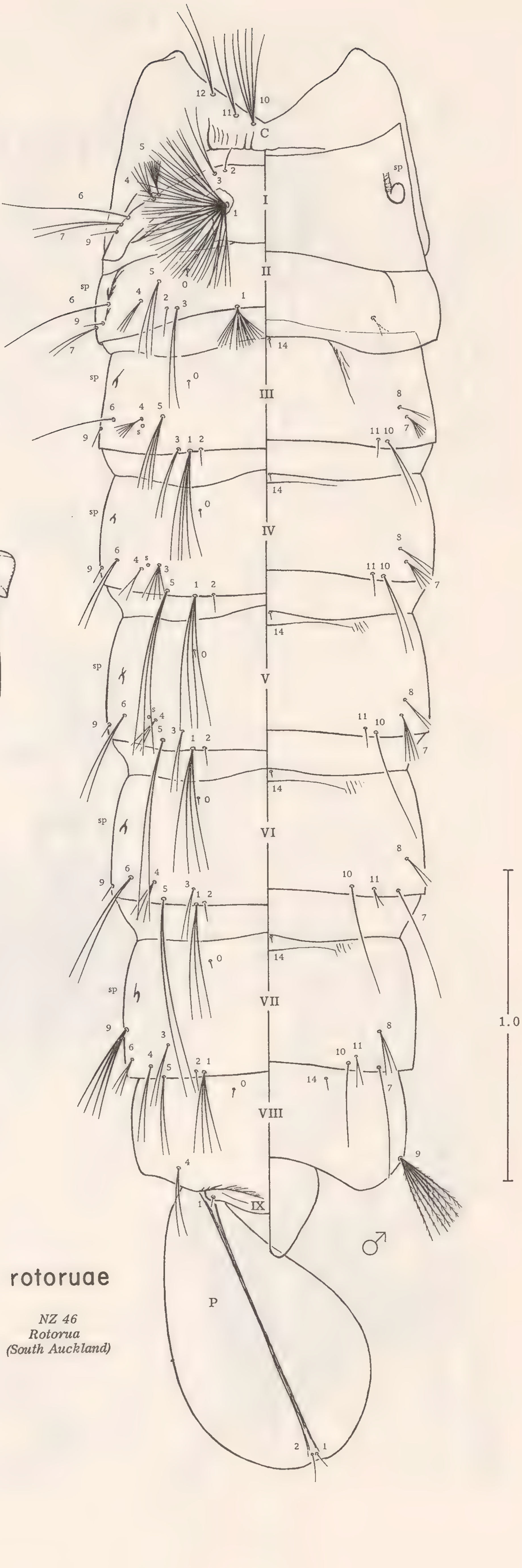
harrisi

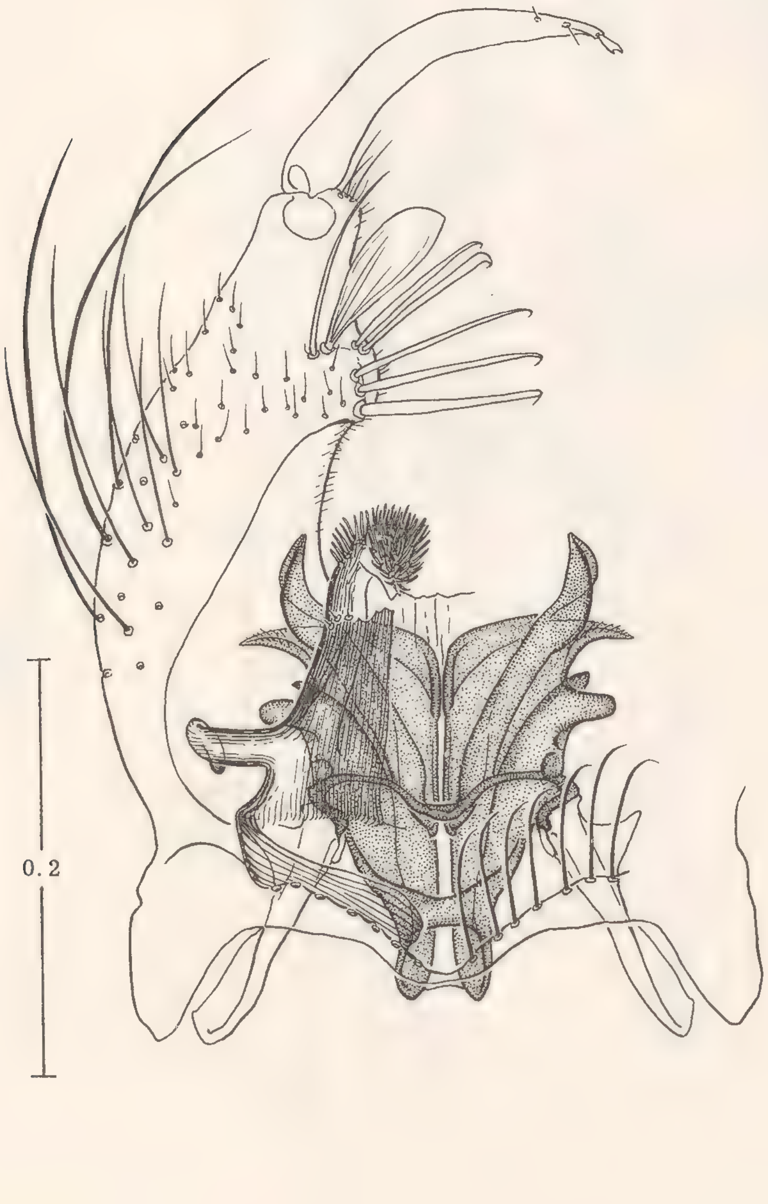
NZ 138
Great Barrier Island
(South Auckland)

CULEX

Fig. 13





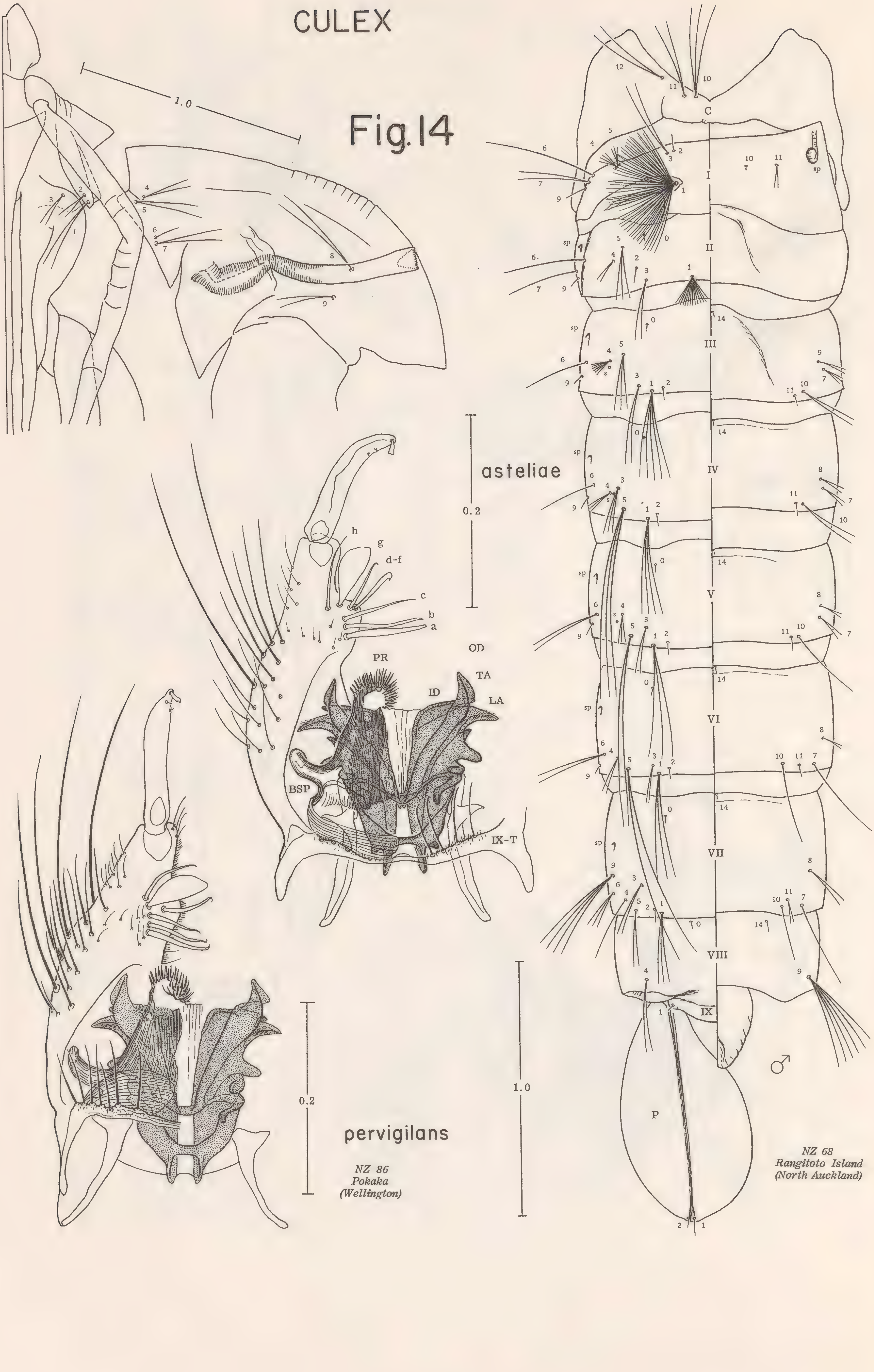


rotoruae

NZ 46
Rotorua
(South Auckland)

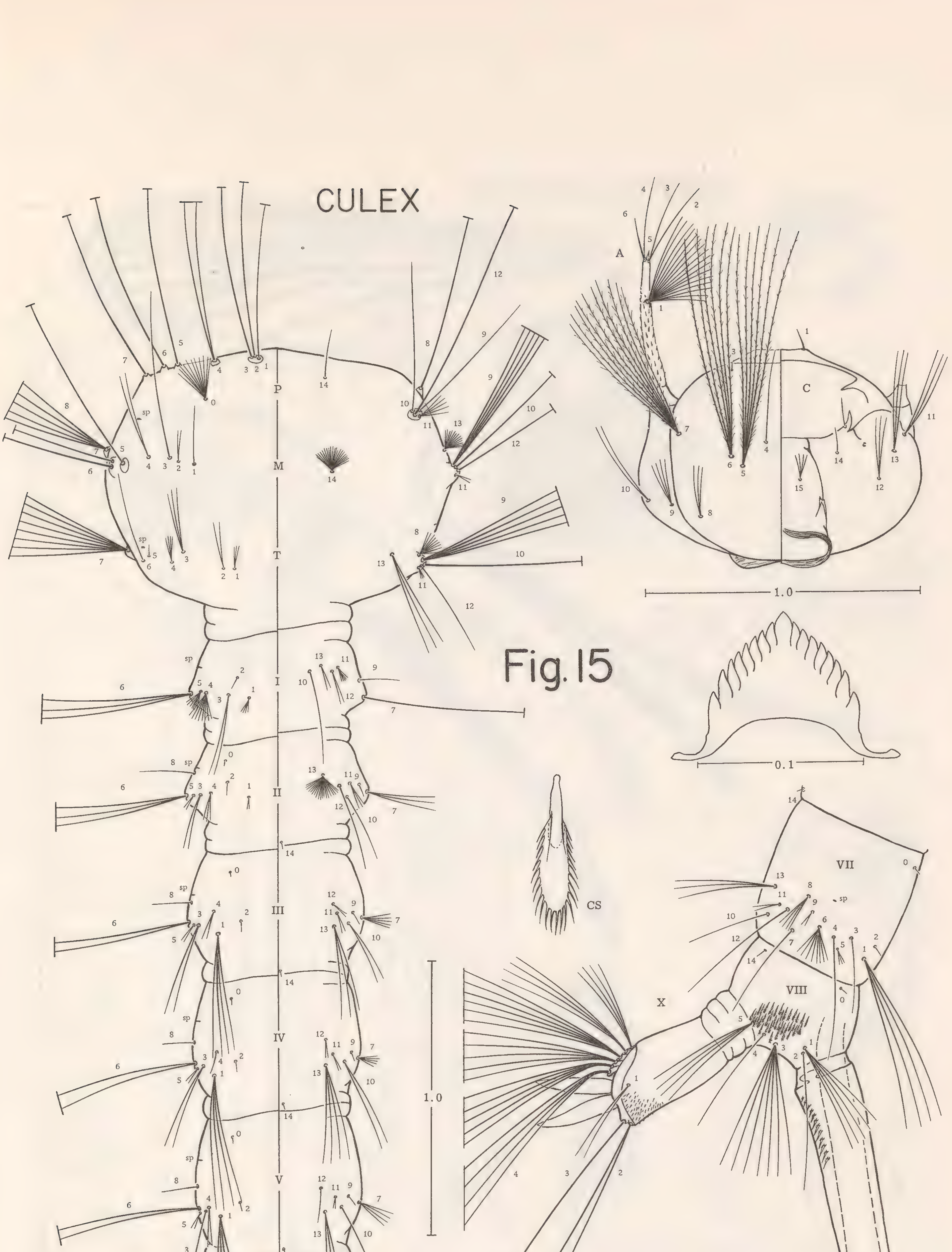
CULEX

Fig.14



NZ 86
Pokaka
(Wellington)

NZ 68
Rangitoto Island
(North Auckland)



CULEX

Fig. 15

asteliae

NZ 68
Rangitoto Island
(North Auckland)

COQUILLETTIDIA

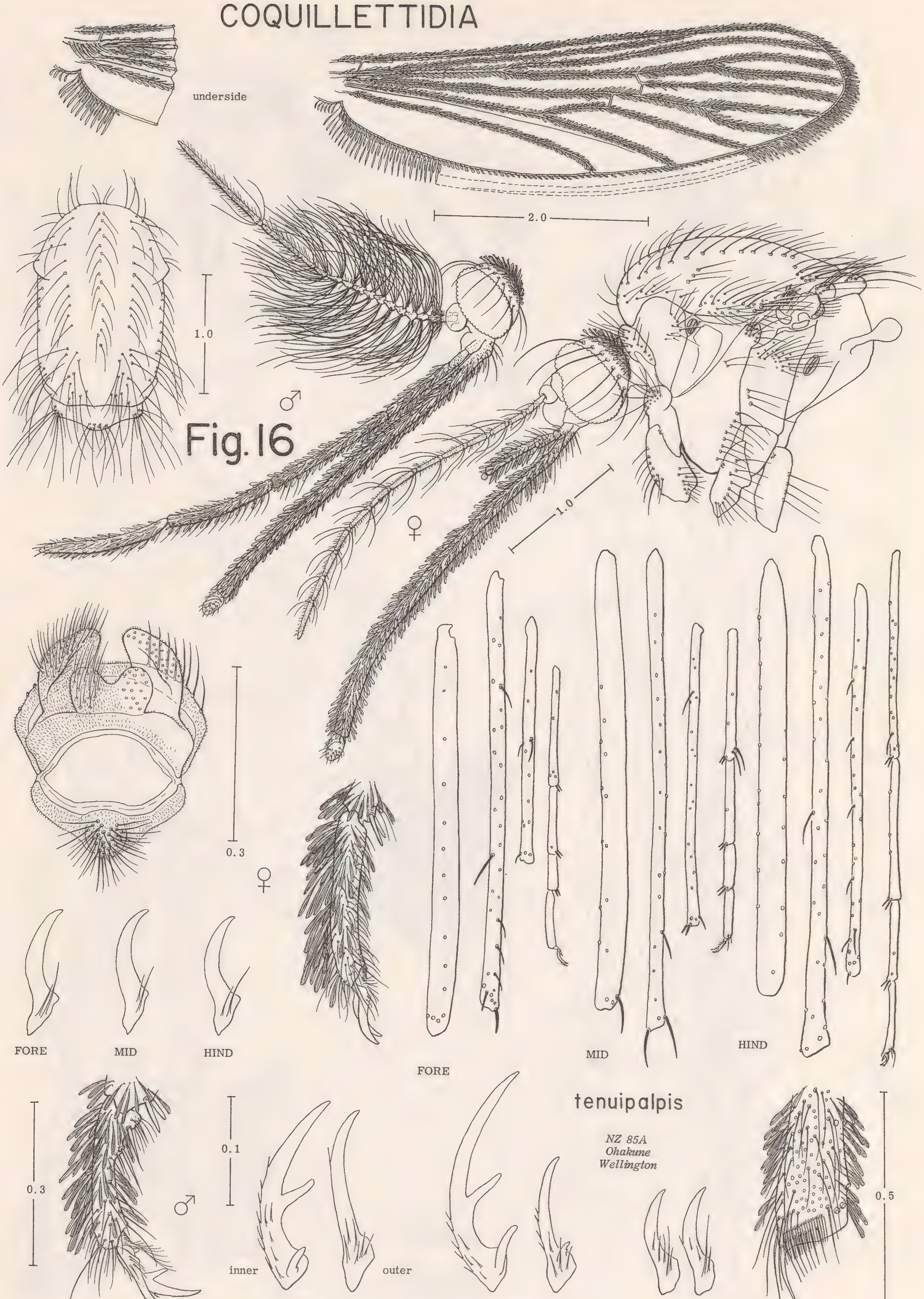


Fig. 16

tenuipalpis

NZ 85A
Ohakune
Wellington

COQUILLETTIDIA

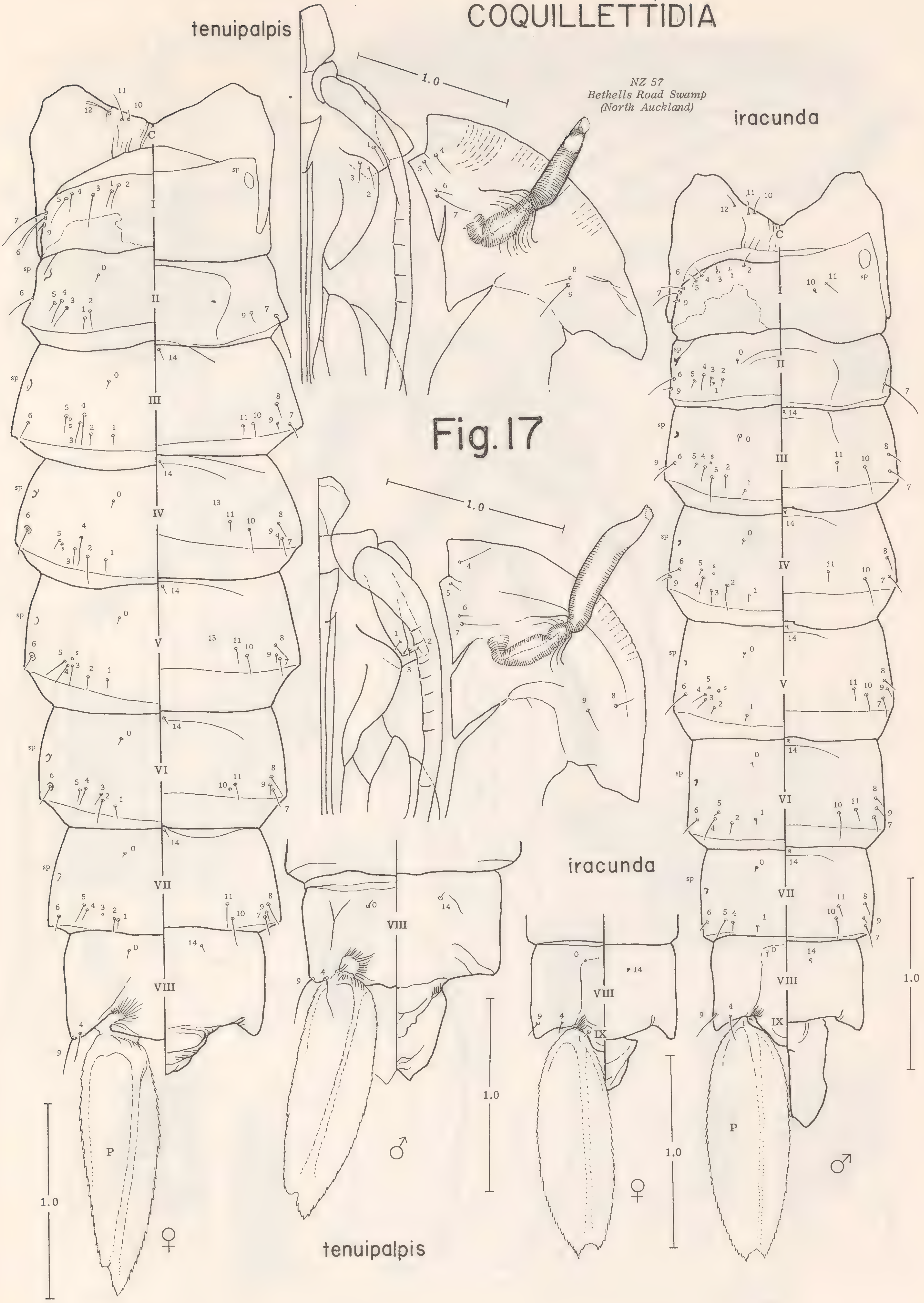


Fig. 17

NZ 57
Bethells Road Swamp
(North Auckland)

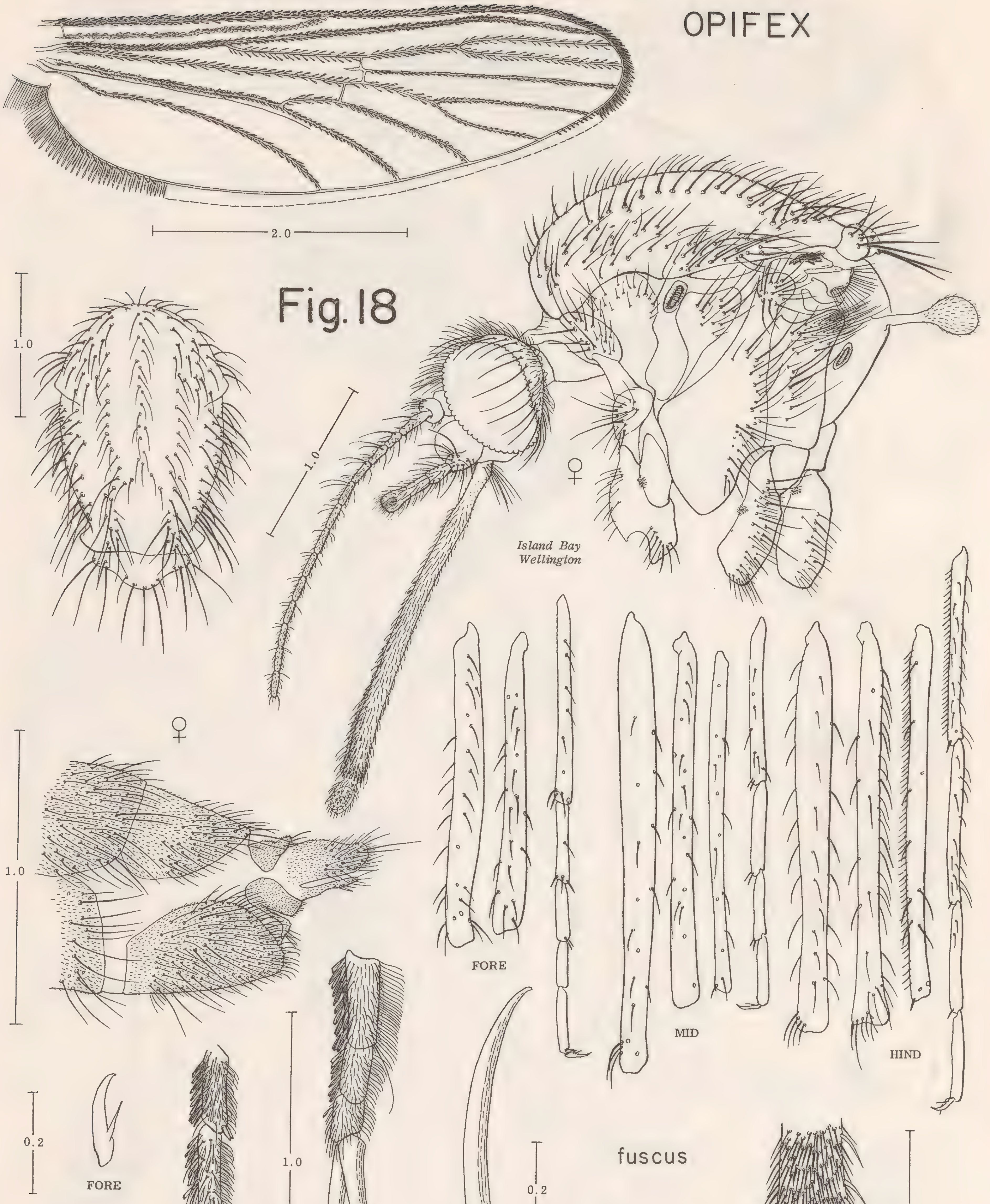
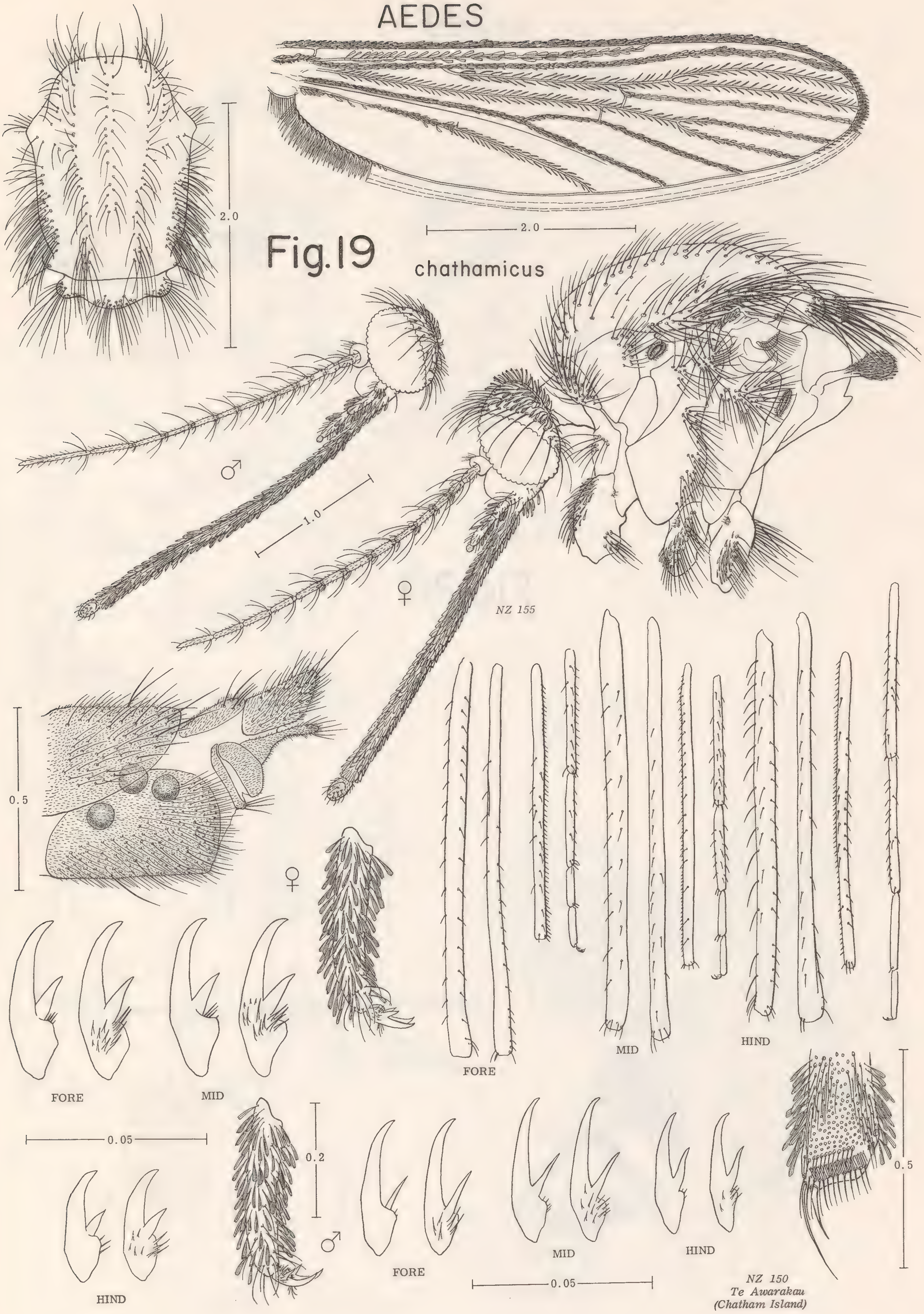


Fig. 18

OPIFEX

fuscus



AEDES

Fig. 19 chathamicus

NZ 150
Te Awarakau
(Chatham Island)

AEDES

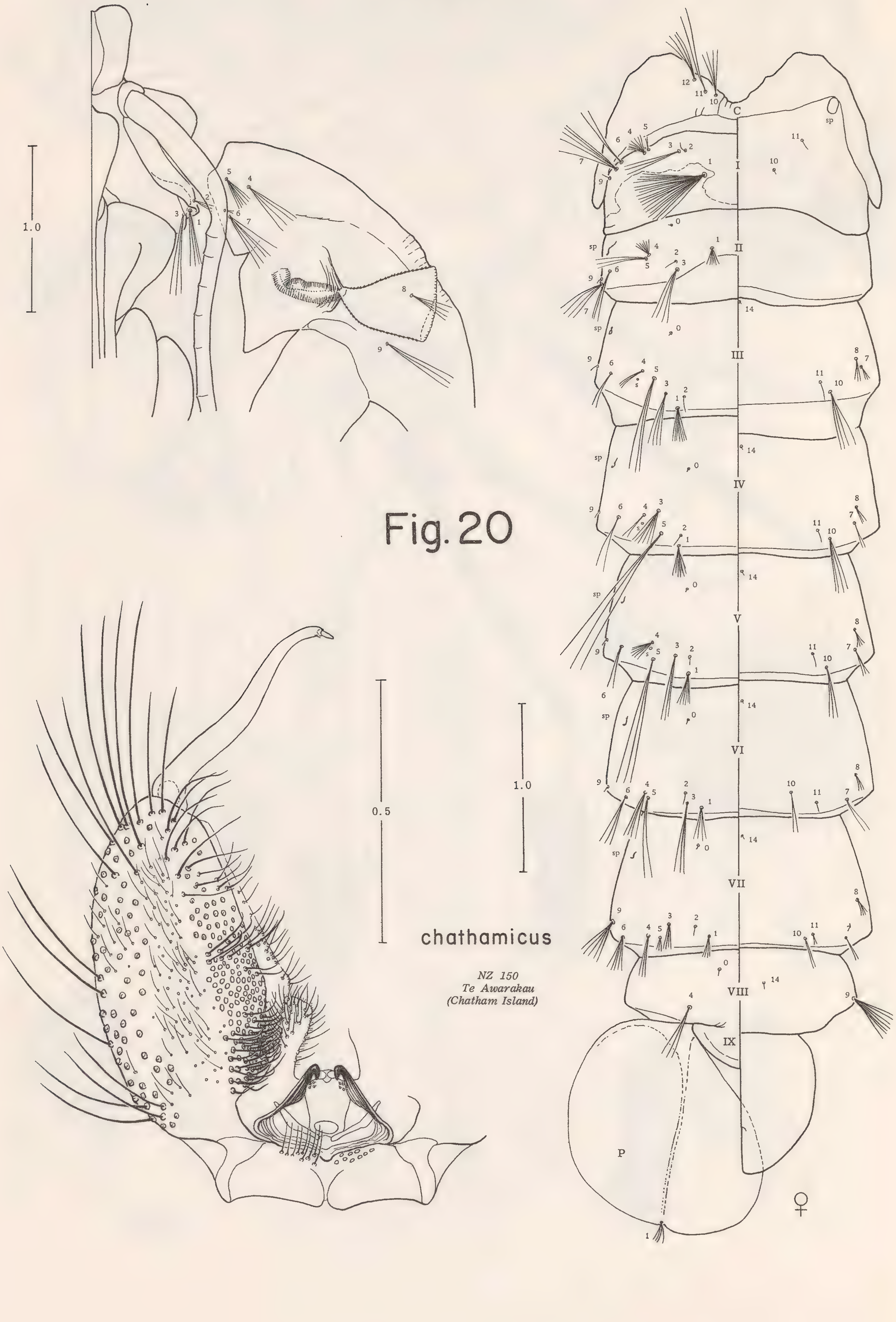


Fig. 20

chathamicus

NZ 150
Te Awarakau
(Chatham Island)

AEDES

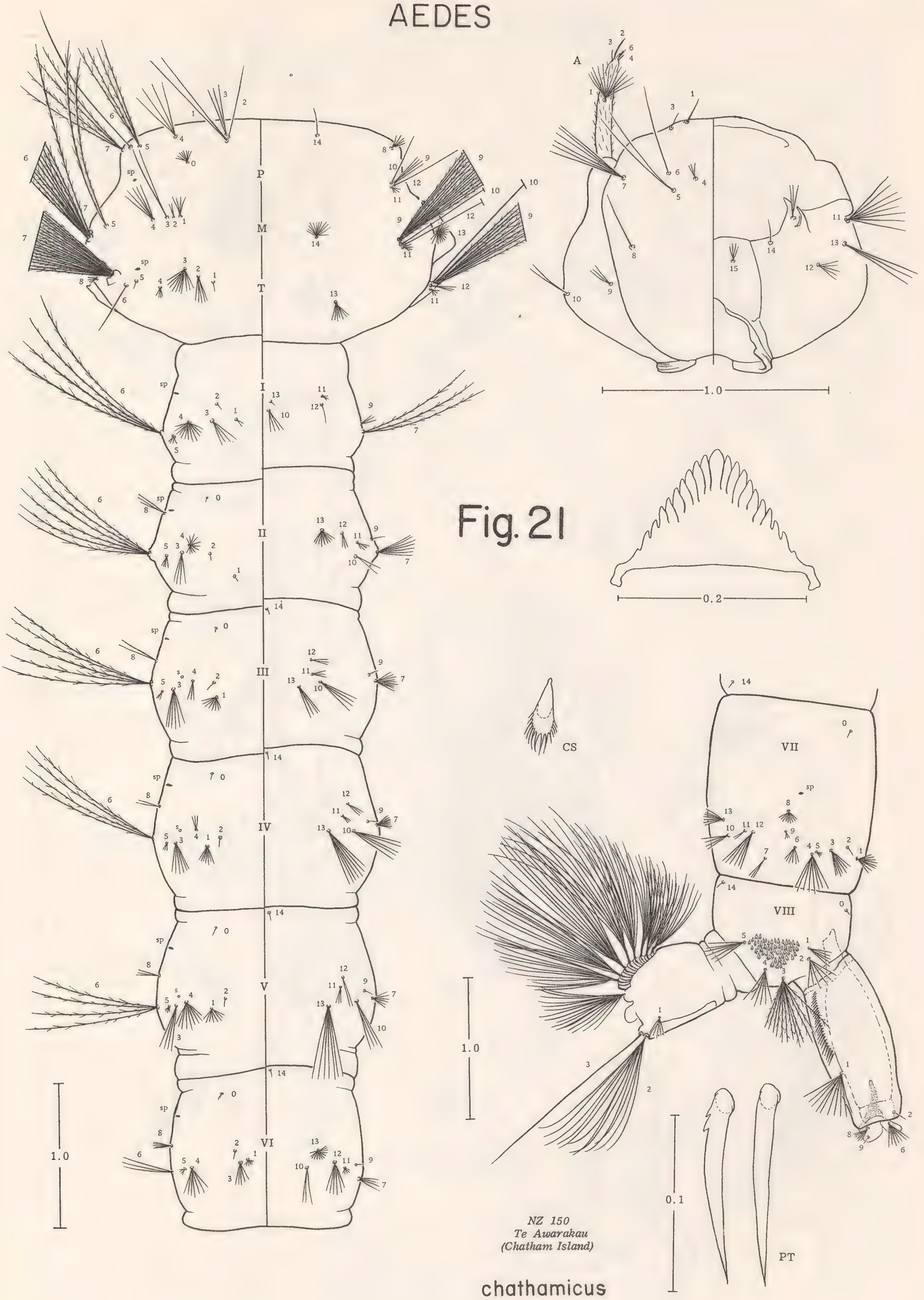


Fig. 21

NZ 150
Te Awarakau
(Chatham Island)

chathamicus

AEDES

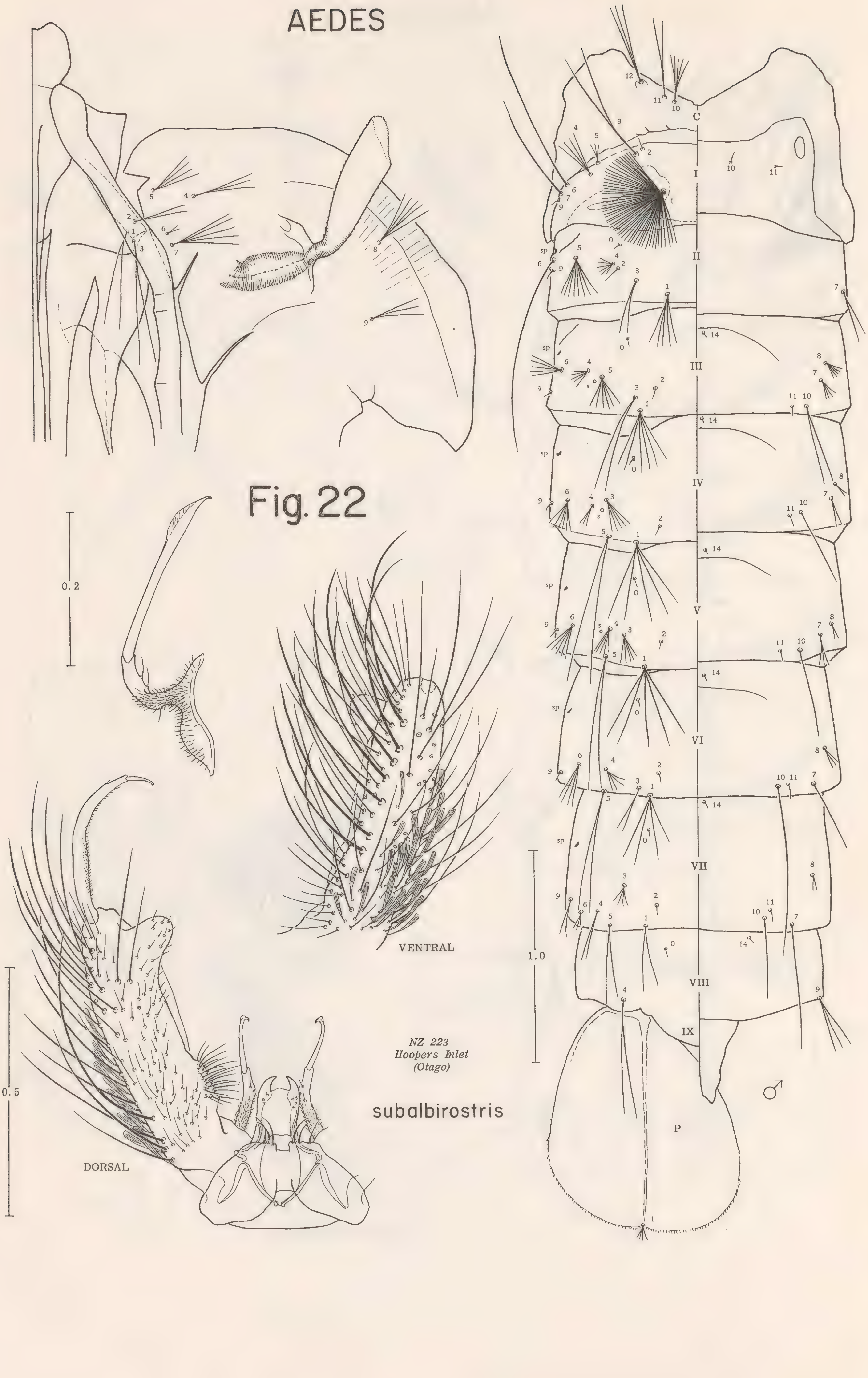


Fig. 22

NZ 223
Hoopers Inlet
(Otago)

subalbirostris

AEDES

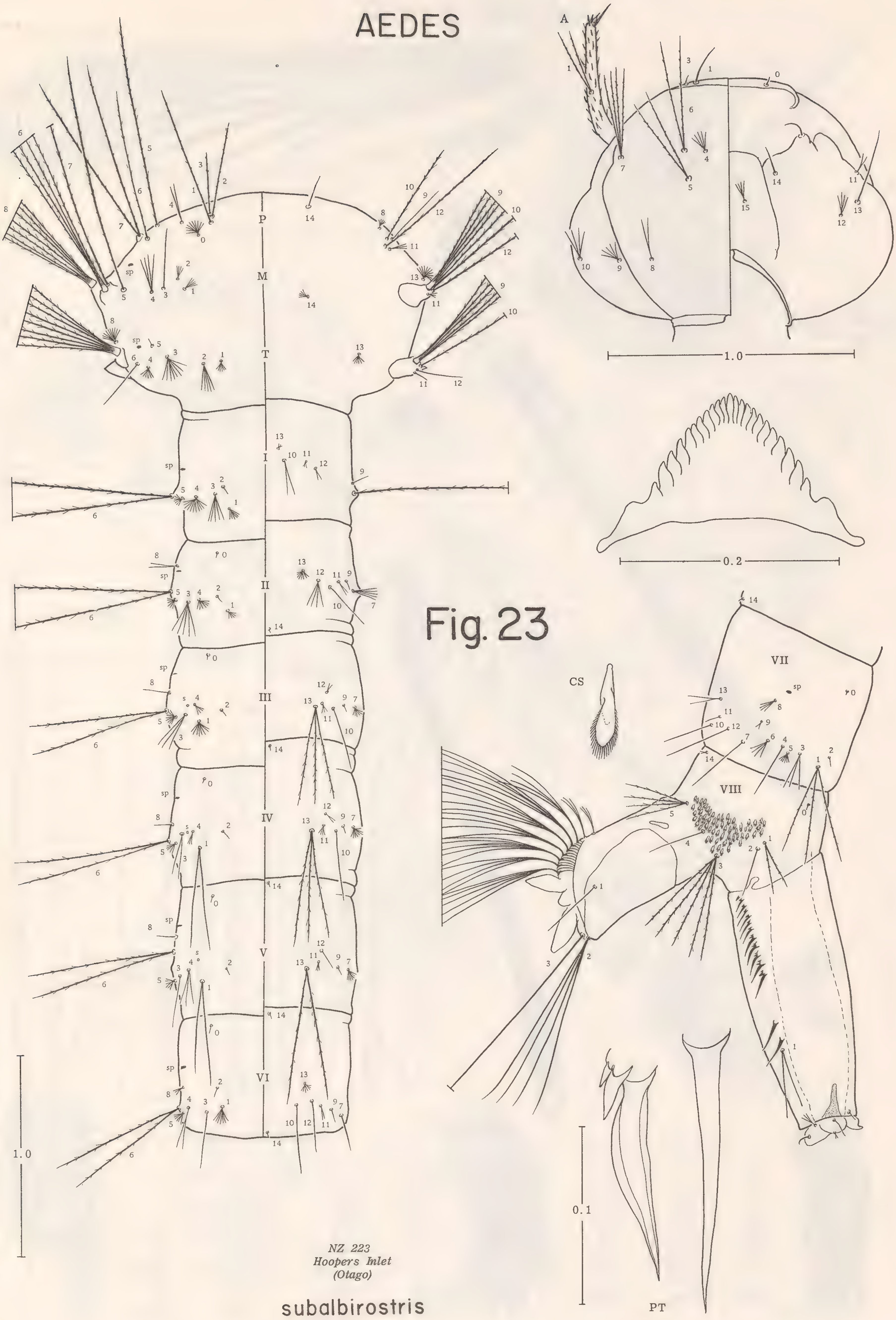


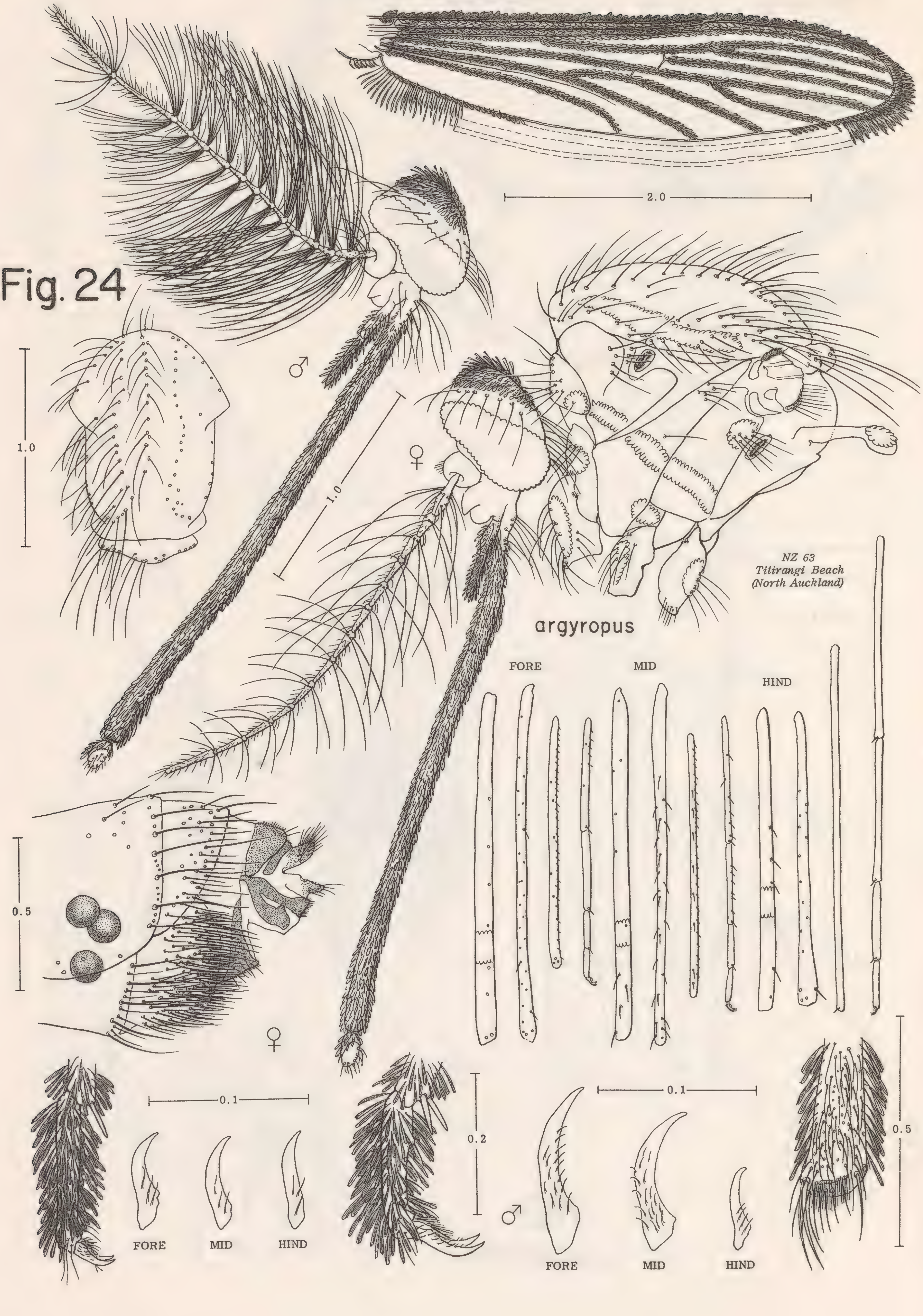
Fig. 23

NZ 223
Hoopers Inlet
(Otago)

subalbirostris

MAORIGOELDIA

Fig. 24



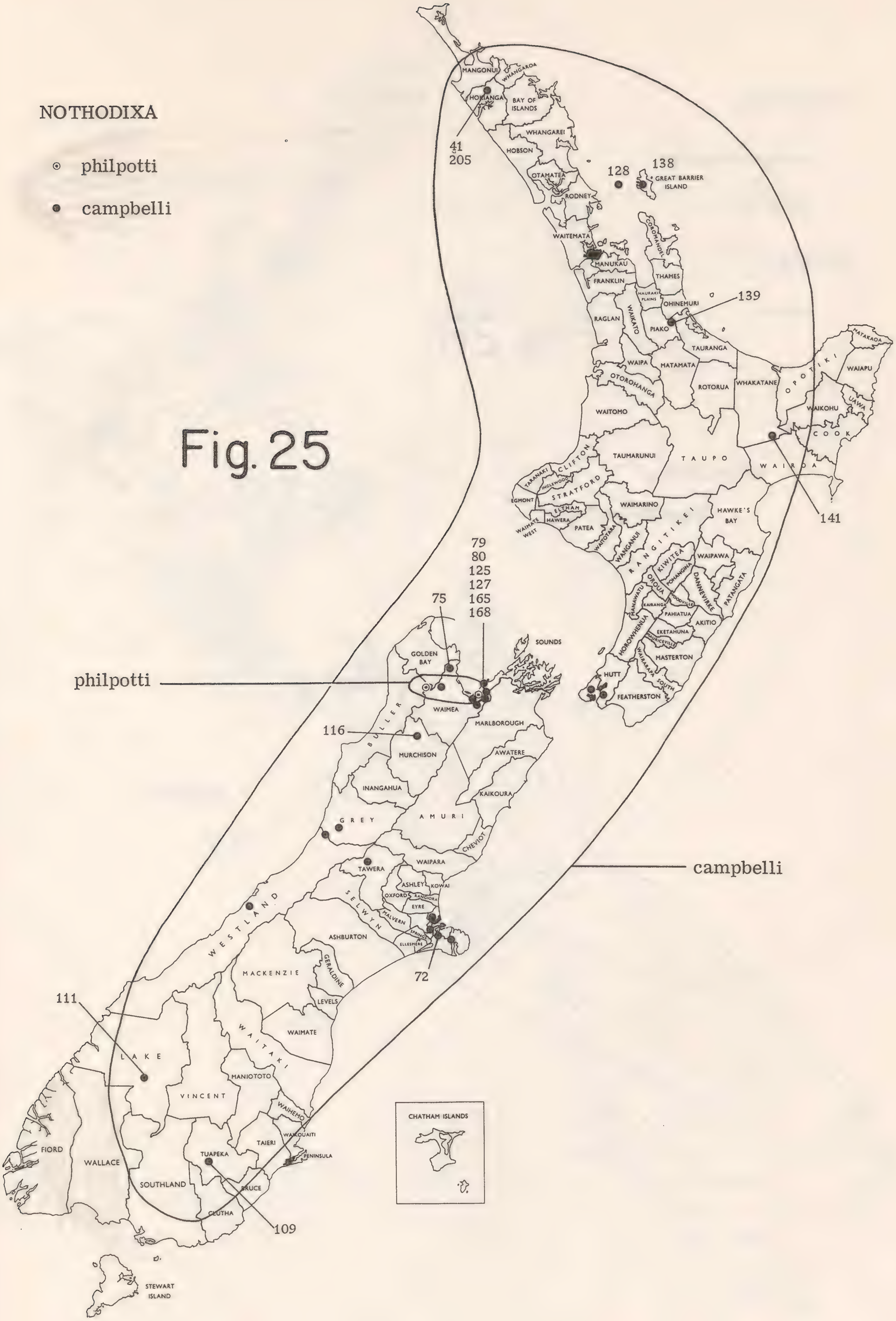
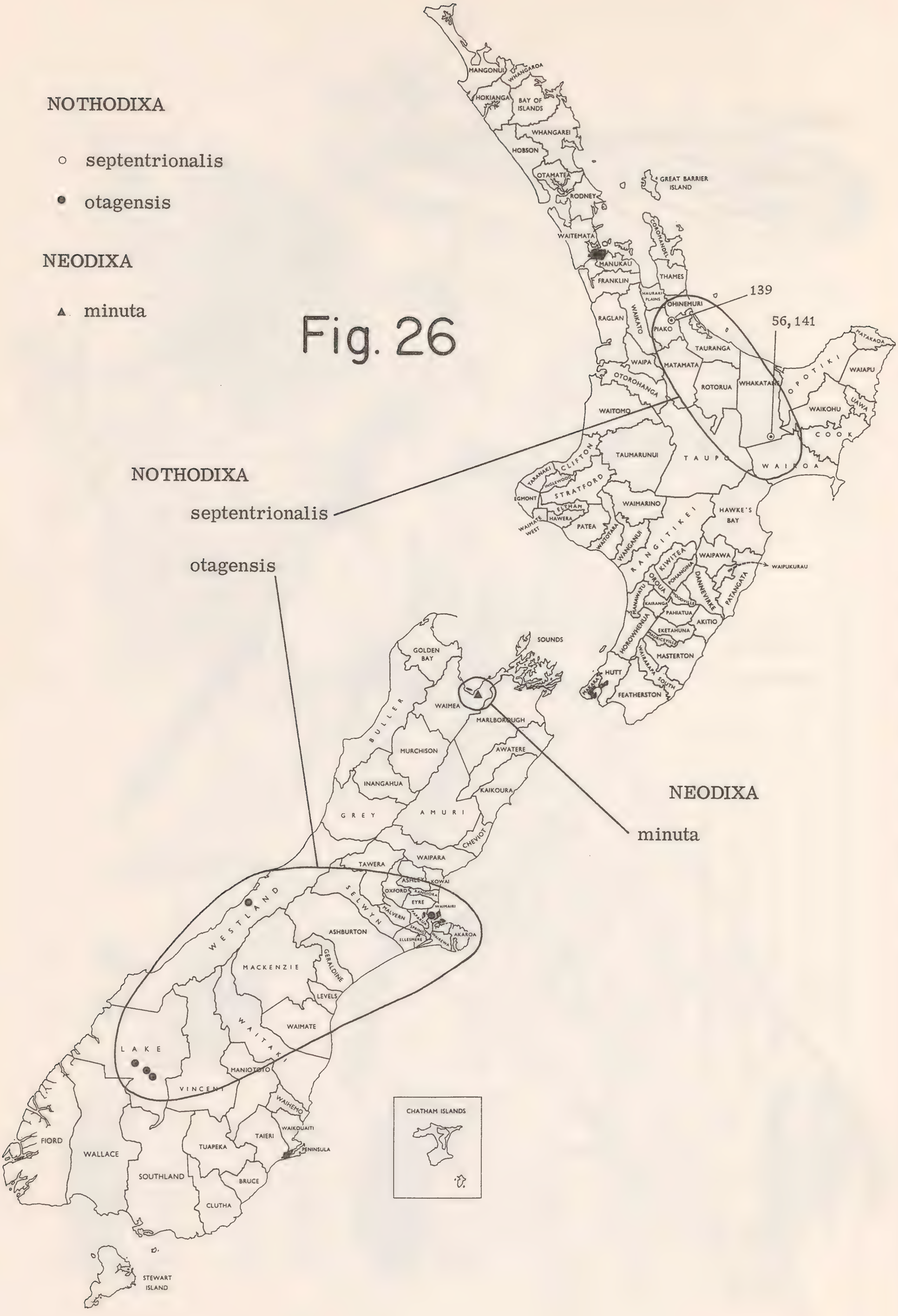


Fig. 25
NOTHODIXA
⊙ philpotti
● campbelli
philpotti
campbelli
41
205
128
138
139
141
79
80
125
127
165
168
75
116
72
111
109
MANGONUI
WHANGAROA
HOKIANGA
BAY OF ISLANDS
WHANGAREI
HOBSON
OTAMATEA
RODNEY
GREAT BARRIER ISLAND
WAITEMATA
COROMANDEL
MANUKAU
FRANKLIN
THAMES
HAURAKI PLAINS
OHINEMURI
RAGLAN
WAIKATO
PIAKO
TAURANGA
WAIPA
MATAMATA
OTOROHANGA
ROTORUA
WHAKATANE
OPOTIKI
MATAKAOA
WAIAPU
UAWA
WAIKOHU
COOK
WAITOMO
TAUMARUNUI
TAUPO
WAIROA
CLIFTON
TARANAKI
INGLEWOOD
STRATFORD
EGMONT
ELTHAM
HAWERA
WAIMATE WEST
PATEA
WAITOTARA
WAIMARINO
WANGANUI
RANGITIKEI
HAWKE'S BAY
KIWITEA
WAIPAWA
OROUA
POHANGINA
DANNEVIRKE
PATANGATA
MANAWATU
KAIRANGA
WOODVILLE
PAHIATUA
AKITIO
HOROWHENUA
EKETAHUNA
MAURICEVILLE
MASTERTON
WAIRARAPA SOUTH
HUTT
FEATHERSTON
SOUNDS
GOLDEN BAY
WAIMEA
MARLBOROUGH
BULLER
MURCHISON
AWATERE
INANGAHUA
KAIKOURA
AMURI
GREY
CHEVIOT
TAWERA
WAIPARA
ASHLEY
KOWAI
OXFORD
RANGIORA
EYRE
MALVERN
SELWYN
SPRINGS
ELLESMERE
WESTLAND
ASHBURTON
GERALDINE
MACKENZIE
LEVELS
WAITAKI
WAIMATE
LAKE
MANIOTOTO
VINCENT
WAIHEMO
WAIKOUAITI
TAIERI
PENINSULA
FIORD
WALLACE
TUAPEKA
SOUTHLAND
BRUCE
CLUTHA
CHATHAM ISLANDS
STEWART ISLAND

Fig. 26


NOTHODIXA
○ septentrionalis
● otagensis
NEODIXA
▲ minuta
139
56, 141
NOTHODIXA
septentrionalis
otagensis
NEODIXA
minuta
MANGONUI
WHANGAROA
HOKIANGA
BAY OF ISLANDS
WHANGAREI
HOBSON
OTAMATEA
RODNEY
GREAT BARRIER ISLAND
WAITEMATA
MANUKAU
FRANKLIN
COROMANDEL
THAMES
HAURAKI PLAINS
OHINEMURI
RAGLAN
WAIKATO
PIAKO
TAURANGA
WAIPA
MATAMATA
ROTORUA
WHAKATANE
OPOTIKI
MATAKAOA
WAIAPU
UAWA
WAIKOHU
COOK
OTOROHANGA
WAITOMO
TAUMARUNUI
TAUPO
WAIROA
TARANAKI
CLIFTON
INGLEWOOD
EGMONT
STRATFORD
ELTHAM
HAWERA
WAIMATE WEST
PATEA
WAIMARINO
WAITOTARA
WANGANUI
RANGITIKEI
HAWKE'S BAY
WAIPAWA
WAIPUKURAU
KIWITEA
POHANGINA
OROUA
MANAWATU
DANNEVIRKE
WOODVILLE
PATANGATA
KAIRANGA
PAHIATUA
AKITIO
HOROWHENUA
EKETAHUNA
MAURICEVILLE
WAIRARAPA SOUTH
MASTERTON
HUTT
MAKARA
FEATHERSTON
SOUNDS
GOLDEN BAY
WAIMEA
MARLBOROUGH
BULLER
MURCHISON
AWATERE
INANGAHUA
KAIKOURA
GREY
AMURI
CHEVIOT
WAIPARA
TAWERA
ASHLEY
KOWAI
OXFORD
RANGIORA
EYRE
WAIMAIRI
SELWYN
MALVERN
PARADISE
SPRINGS
HALSWELL
ELLESMERE
WAIREWA
AKAROA
WESTLAND
ASHBURTON
MACKENZIE
GERALDINE
LEVELS
WAIMATE
WAITAKI
LAKE
MANIOTOTO
VINCENT
WAIHEMO
WAIKOUAITI
TAIERI
PENINSULA
FIORD
WALLACE
TUAPEKA
SOUTHLAND
BRUCE
CLUTHA
STEWART ISLAND
CHATHAM ISLANDS

PARADIXA

● neozelandica

Fig. 27

PARADIXA

● fuscinervis

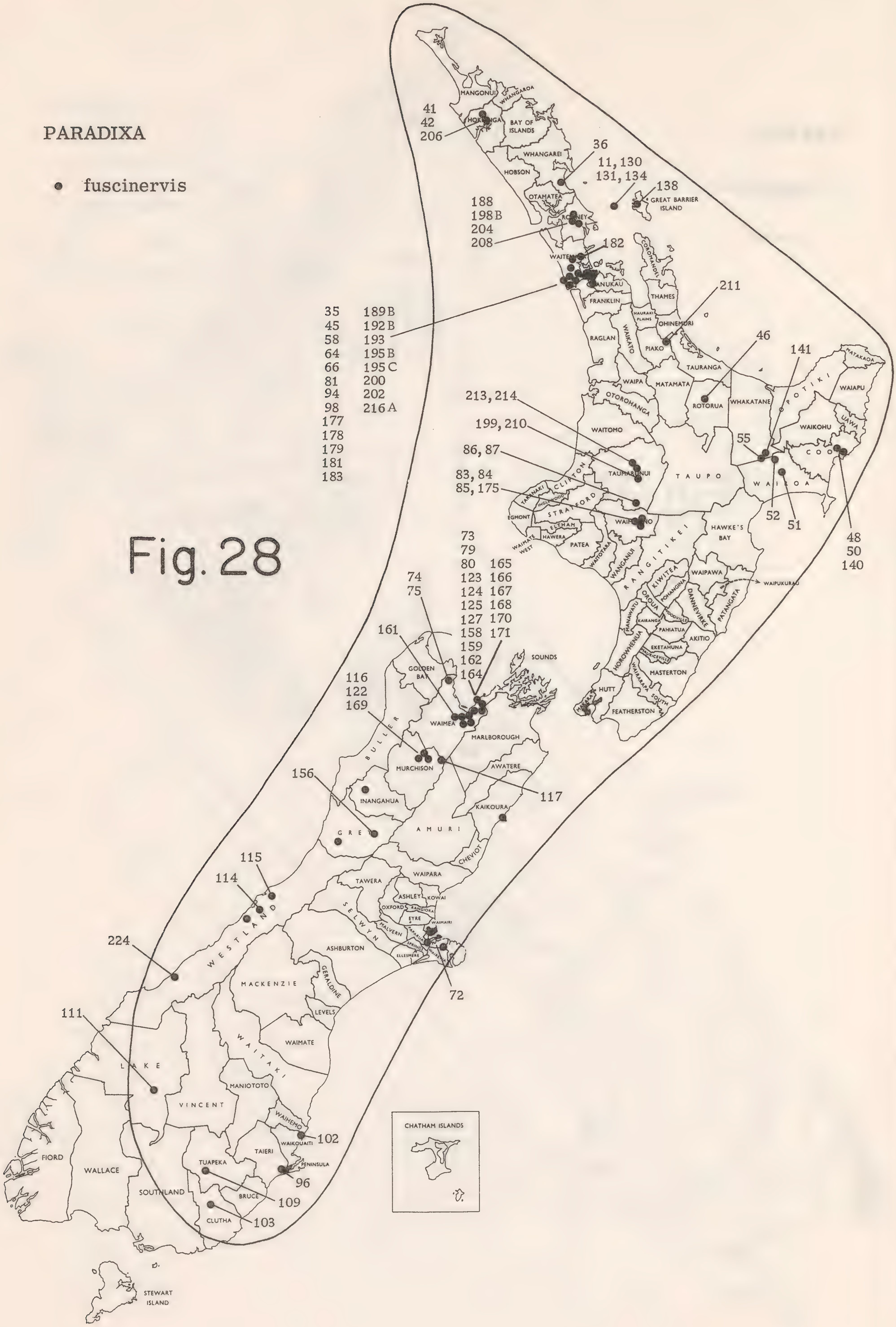


Fig. 28

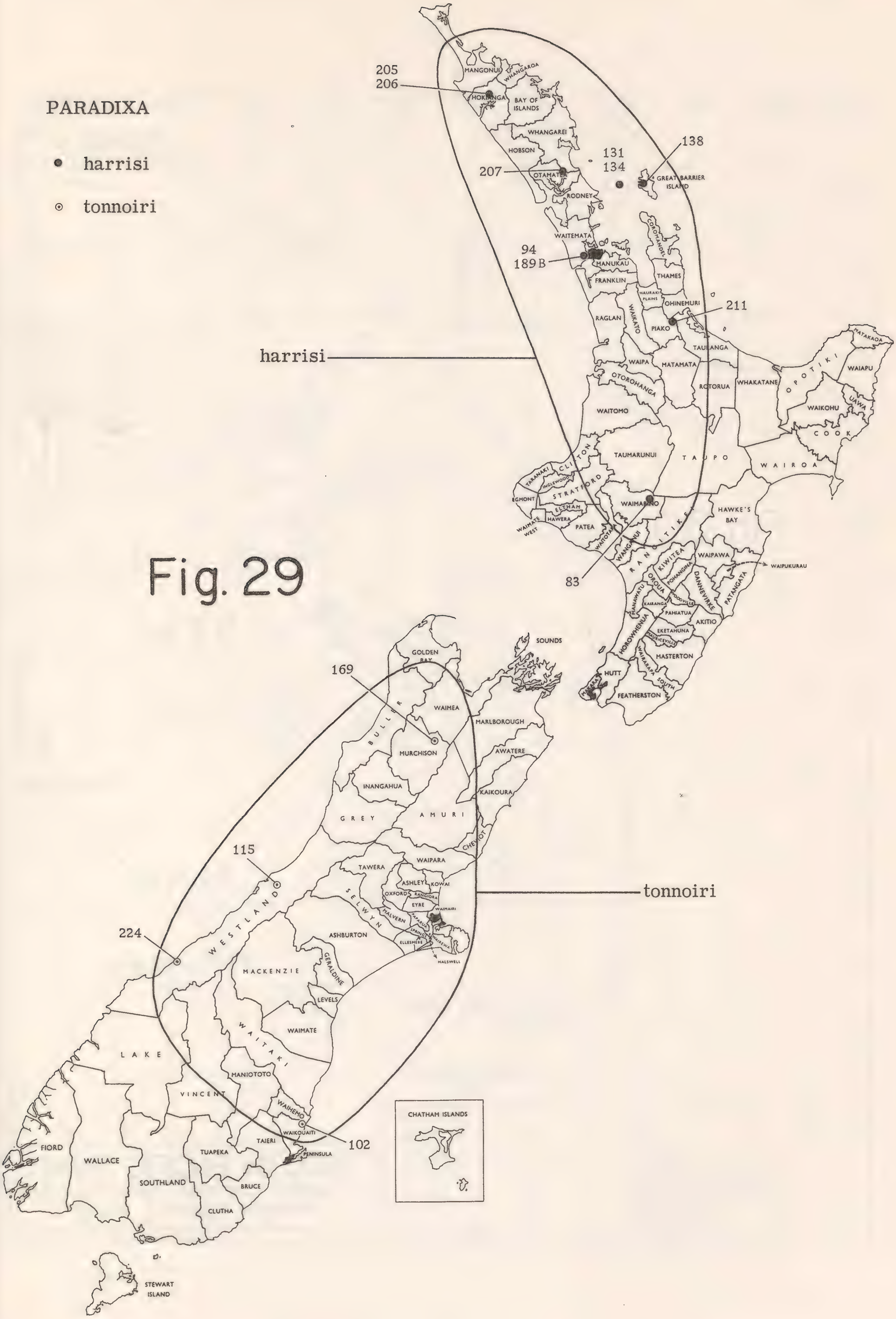

PARADIXA
● harrisi
⊙ tonnoiri
harrisi
tonnoiri
205
206
207
131
134
138
94
189 B
211
83
169
115
224
102
MANGONUI
WHANGAROA
HOKIANGA
BAY OF ISLANDS
WHANGAREI
HOBSON
OTAMATEA
RODNEY
GREAT BARRIER ISLAND
WAITEMATA
MANUKAU
FRANKLIN
COROMANDEL
THAMES
HAURAKI PLAINS
OHINEMURI
RAGLAN
WAIKATO
PIAKO
TAURANGA
WAIPA
MATAMATA
OTOROHANGA
ROTORUA
WHAKATANE
OPOTIKI
MATAKAOA
WAIAPU
WAIKOHU
UAWA
COOK
WAITOMO
TAUMARUNUI
TAUPO
WAIROA
CLIFTON
TARANAKI
INGLEWOOD
STRATFORD
EGMONT
ELTHAM
HAWERA
WAIMATE WEST
PATEA
WAIMARINO
WAITOTARA
WANGANUI
RANGITIKEI
HAWKE'S BAY
KIWITEA
POHANGINA
OROUA
MANAWATU
WAIPAWA
WAIPUKURAU
PATANGATA
DANNEVIRKE
WOODVILLE
KAIRANGA
PAHIATUA
AKITIO
HOROWHENUA
EKETAHUNA
MAURICEVILLE
WAIRARAPA SOUTH
MASTERTON
HUTT
MAKARA
FEATHERSTON
SOUNDS
GOLDEN BAY
WAIMEA
MARLBOROUGH
BULLER
MURCHISON
AWATERE
INANGAHUA
KAIKOURA
GREY
AMURI
CHEVIOT
WAIPARA
TAWERA
ASHLEY
KOWAI
OXFORD
RANGIORA
EYRE
WAIMAIRI
MALVERN
PAPARUA
SPRINGS
HEATHCOTE
ELLESMERE
HALSWELL
SELWYN
WESTLAND
ASHBURTON
GERALDINE
MACKENZIE
LEVELS
WAIMATE
WAITAKI
LAKE
MANIOTOTO
VINCENT
WAIHEMO
WAIKOUAITI
PENINSULA
TAIERI
FIORD
WALLACE
TUAPEKA
SOUTHLAND
BRUCE
CLUTHA
STEWART ISLAND
CHATHAM ISLANDS

Fig. 29


Fig. 30

CULEX
● pervigilans
NORFOLK
LORD HOWE
KERMADEC
Raoul
Macauley
Curtis
Three Kings
Great Barrier
NORTH
ISLAND
Auckland
Taranaki
Bay
Wellington
Hawkes
SOUTH
ISLAND
Nelson
Marlborough
Westland
Canterbury
Otago
NEW
ZEALAND
Chatham
Pitt
CHATHAM
Solander
Stewart
Snares
BOUNTY
ANTIPODES
AUCKLAND
Auckland
Adams
CAMPBELL
MACQUARIE
Judge a Clerk
Macquarie
Bishop a Clerk
160
162
164
166
168
170
172
174
176
178
East
180
West
178
30
32
34
36
38
40
42
44
46
48
50
52
54
154
156
158
160
162
164
166
168
170
172
174
176
178
180
178
176
174
SOUTH PACIFIC-Sheet 5
LAMBERT CONFORMAL CONIC PROJECTION
STANDARD PARALLELS 33° and 45°
100
200
300
400
500
STATUTE MILES

CULEX

● pervigilans

Fig. 31

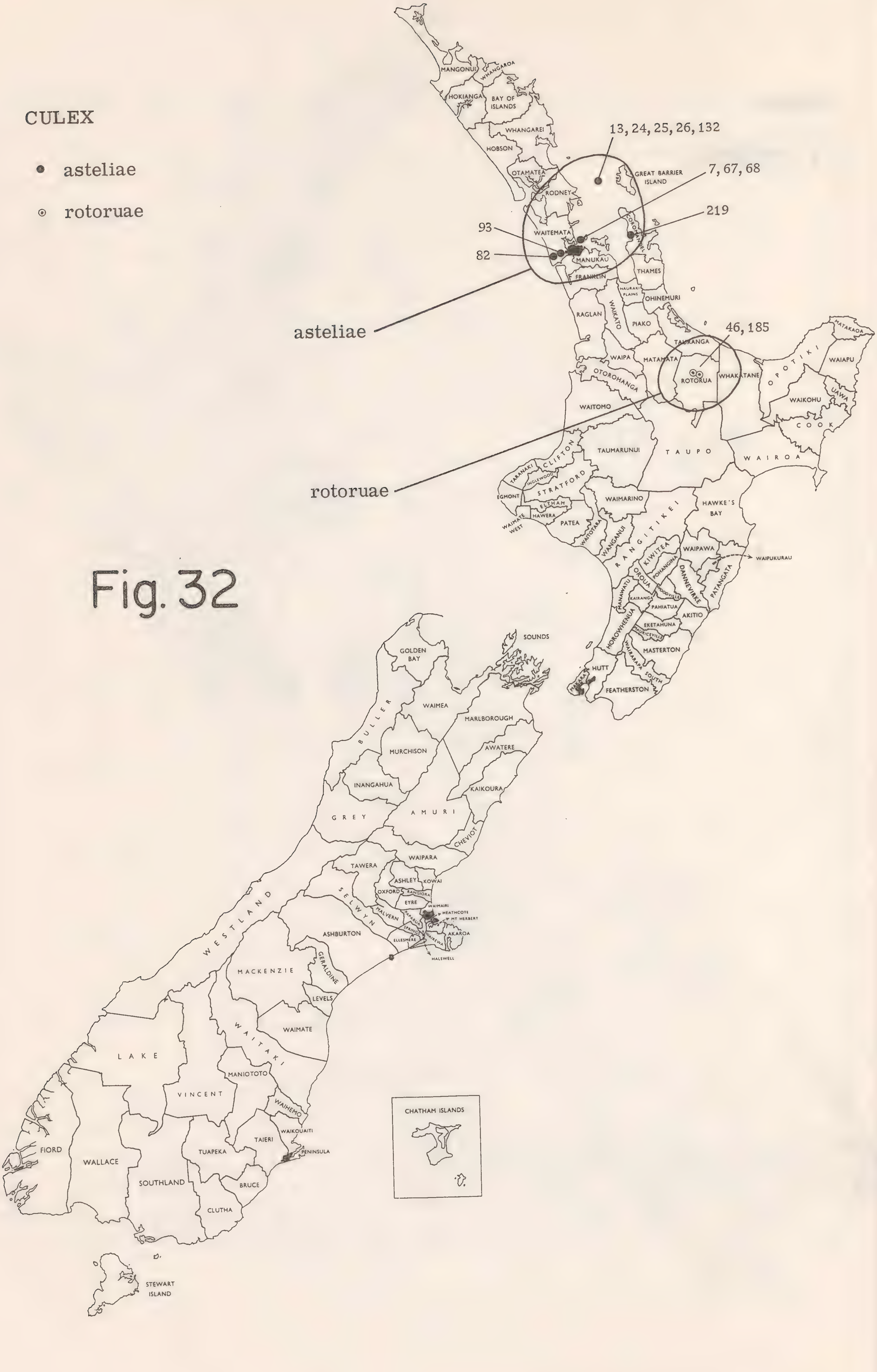

CULEX
● asteliae
⊙ rotoruae
13, 24, 25, 26, 132
7, 67, 68
219
93
82
asteliae
46, 185
rotoruae
MANGONUI
WHANGAROA
HOKIANGA
BAY OF ISLANDS
WHANGAREI
HOBSON
OTAMATEA
RODNEY
GREAT BARRIER ISLAND
WAITEMATA
MANUKAU
FRANKLIN
COROMANDEL
THAMES
HAURAKI PLAINS
OHINEMURI
RAGLAN
WAIKATO
PIAKO
TAURANGA
WAIPA
MATAMATA
ROTORUA
WHAKATANE
OTOROHANGA
WAITOMO
TAUMARUNUI
TAUPO
OPOTIKI
MATAKAOA
WAIAPU
WAIKOHU
UAWA
COOK
WAIROA
CLIFTON
TARANAKI
INGLEWOOD
STRATFORD
EGMONT
ELTHAM
HAWERA
WAIMATE WEST
PATEA
WAITOTARA
WANGANUI
WAIMARINO
RANGITIKEI
HAWKE'S BAY
KIWITEA
POHANGINA
OROUA
MANAWATU
KAIRANGA
WOODVILLE
DANNEVIRKE
WAIPAWA
WAIPUKURAU
PATANGATA
PAHIATUA
AKITIO
HOROWHENUA
EKETAHUNA
MAURICEVILLE
MASTERTON
WAIRARAPA SOUTH
HUTT
MAKARA
FEATHERSTON
SOUNDS
GOLDEN BAY
WAIMEA
MARLBOROUGH
BULLER
MURCHISON
AWATERE
INANGAHUA
KAIKOURA
GREY
AMURI
CHEVIOT
WAIPARA
TAWERA
ASHLEY
KOWAI
OXFORD
RANGIORA
EYRE
WAIMAIRI
HEATHCOTE
MT HERBERT
MALVERN
PAPARUA
SPRINGS
WAIREWA
AKAROA
ELLESMERE
HALSWELL
SELWYN
WESTLAND
ASHBURTON
GERALDINE
MACKENZIE
LEVELS
WAIMATE
WAITAKI
LAKE
MANIOTOTO
VINCENT
WAIHEMO
WAIKOUAITI
TAIERI
PENINSULA
TUAPEKA
FIORD
WALLACE
SOUTHLAND
BRUCE
CLUTHA
STEWART ISLAND
CHATHAM ISLANDS

Fig. 32

CULEX

● quinquefasciatus

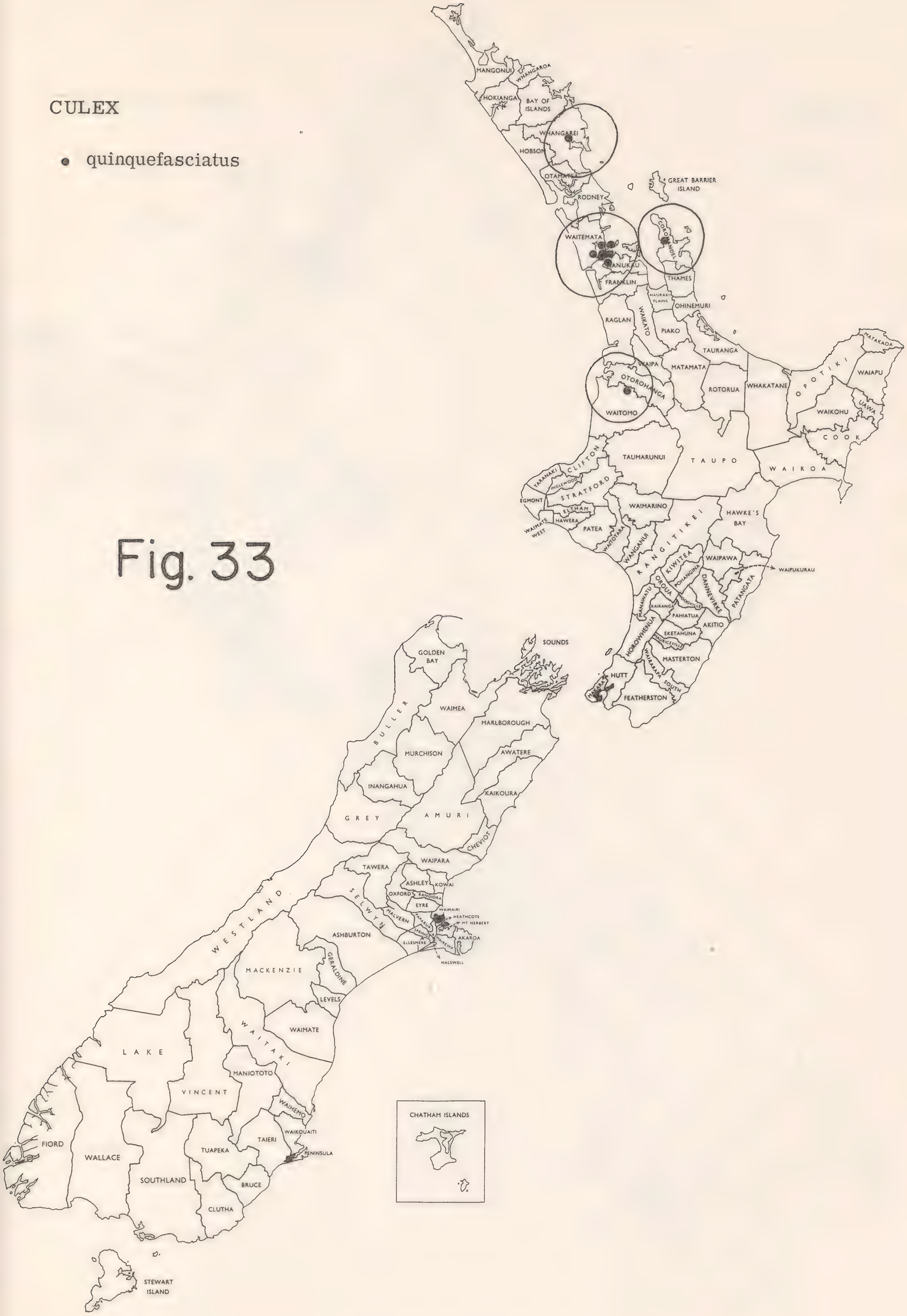


Fig. 33

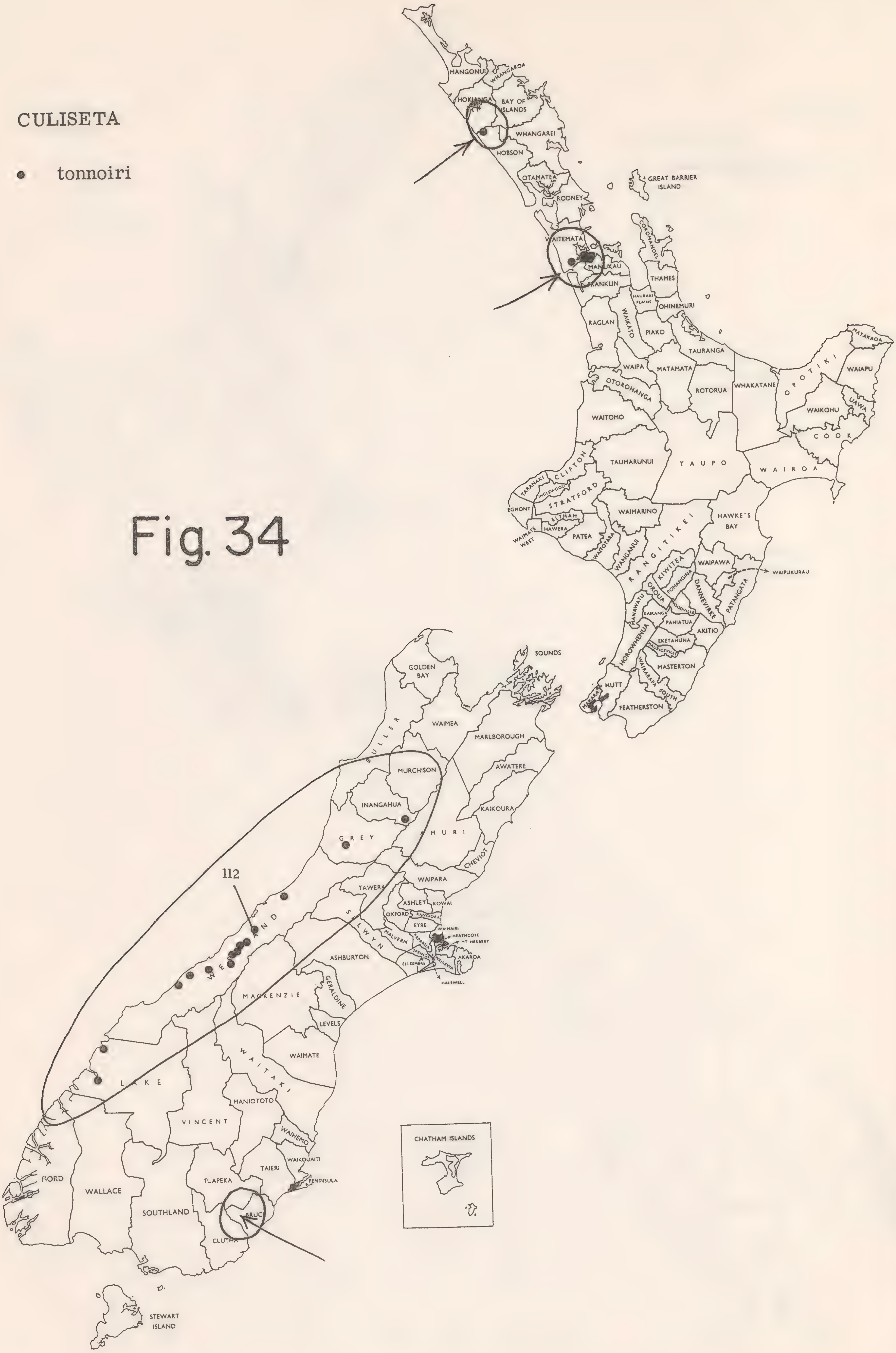

CULISETA
● tonnoiri
MANGONUI
WHANGAROA
HOKIANGA
BAY OF ISLANDS
WHANGAREI
HOBSON
OTAMATEA
RODNEY
GREAT BARRIER ISLAND
WAITEMATA
COROMANDEL
MANUKAU
THAMES
FRANKLIN
HAURAKI PLAINS
OHINEMURI
RAGLAN
WAIKATO
PIAKO
TAURANGA
MATAKAOA
WAIPA
MATAMATA
OPOTIKI
WAIAPU
OTOROHANGA
ROTORUA
WHAKATANE
UAWA
WAIKOHU
WAITOMO
COOK
TAUMARUNUI
TAUPO
WAIROA
CLIFTON
TARANAKI
INGLEWOOD
STRATFORD
EGMONT
ELTHAM
WAIMARINO
HAWKE'S BAY
HAWERA
WAIMATE WEST
PATEA
WAITOTARA
WANGANUI
RANGITIKEI
KIWITEA
WAIPAWA
WAIPUKURAU
POHANGINA
OROUA
MANAWATU
DANNEVIRKE
PATANGATA
WOODVILLE
KAIRANGA
PAHIATUA
HOROWHENUA
AKITIO
EKETAHUNA
MAURICEVILLE
MASTERTON
WAIRARAPA SOUTH
HUTT
FEATHERSTON
SOUNDS
GOLDEN BAY
WAIMEA
MARLBOROUGH
BULLER
AWATERE
MURCHISON
INANGAHUA
KAIKOURA
AMURI
GREY
CHEVIOT
112
WAIPARA
TAWERA
ASHLEY
KOWAI
OXFORD
RANGIORA
EYRE
WAIMAIRI
HEATHCOTE
MT HERBERT
MALVERN
PAPARUA
SPRINGS
SELWYN
WESTLAND
AKAROA
ELLESMERE
WAIREWA
HALSWELL
ASHBURTON
GERALDINE
MACKENZIE
LEVELS
WAIMATE
WAITAKI
LAKE
MANIOTOTO
VINCENT
WAIHEMO
CHATHAM ISLANDS
WAIKOUAITI
TAIERI
PENINSULA
TUAPEKA
FIORD
WALLACE
SOUTHLAND
BRUCE
CLUTHA
STEWART ISLAND

Fig. 34


COQUILLETTIDIA
● tenuipalpis
57
195A
200A
225
85
CHATHAM ISLANDS
STEWART ISLAND

Fig. 35

COQUILLETTIDIA

● iracunda

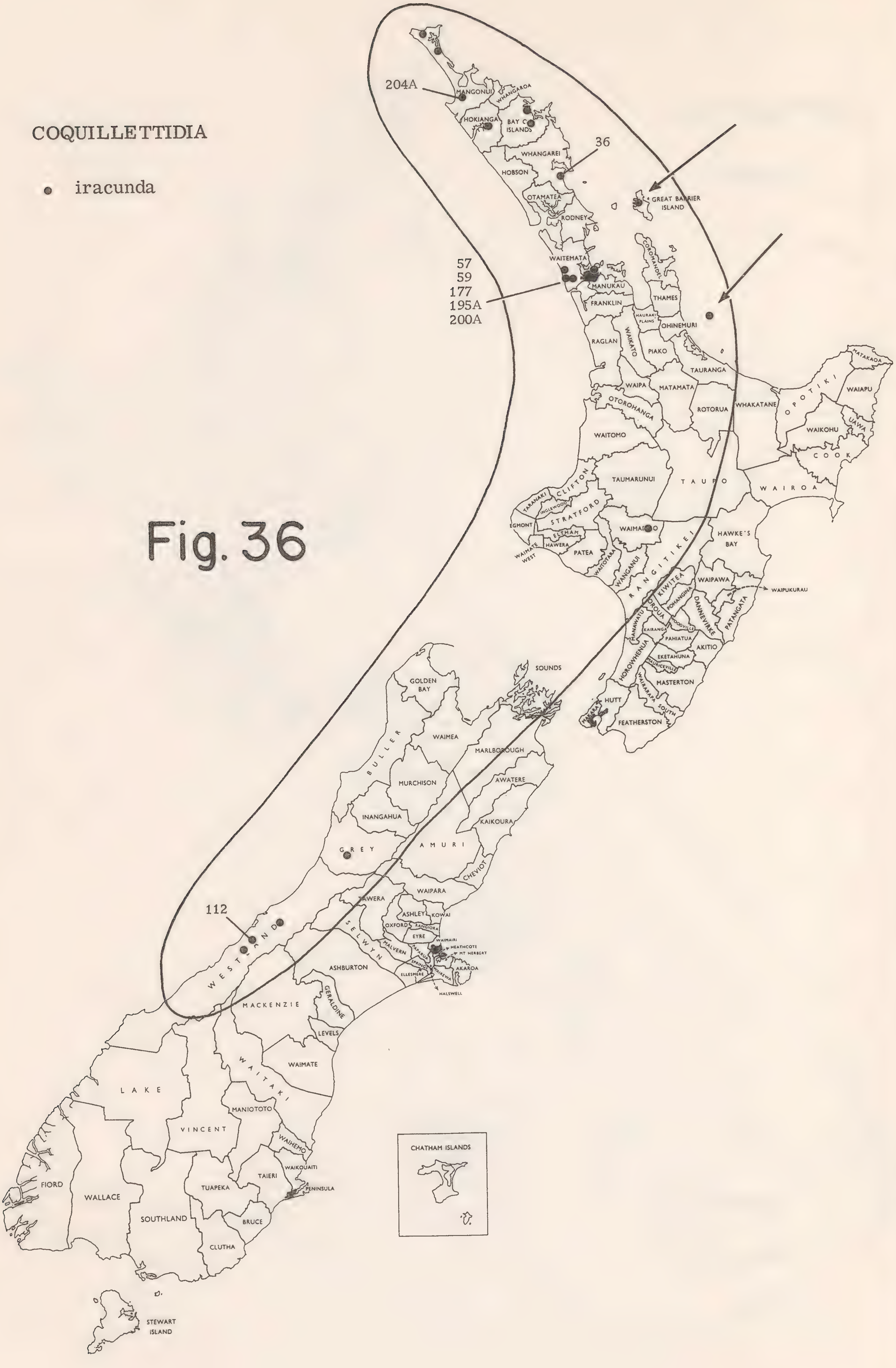


Fig. 36

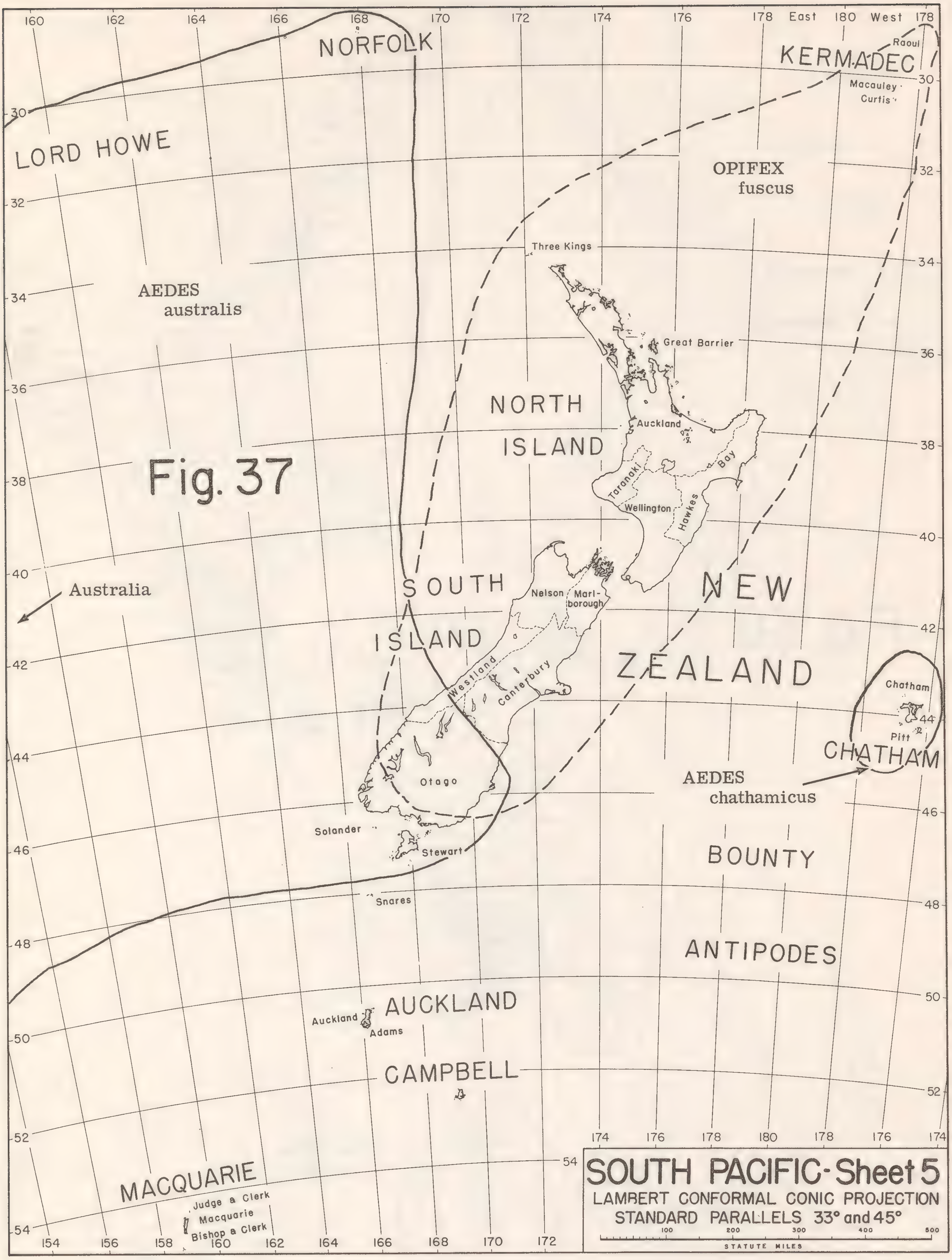


Fig. 37

NORFOLK
KERMADEC
Raoul
Macauley
Curtis
LORD HOWE
OPIFEX
fuscus
Three Kings
AEDES
australis
Great Barrier
NORTH
ISLAND
Auckland
Taranaki
Bay
Wellington
Hawkes
Australia
SOUTH
ISLAND
Nelson
Marlborough
NEW
ZEALAND
Westland
Canterbury
Chatham
Pitt
CHATHAM
Otago
AEDES
chathamicus
Solander
Stewart
BOUNTY
Snares
ANTIPODES
AUCKLAND
Auckland
Adams
CAMPBELL
MACQUARIE
Judge & Clerk
Macquarie
Bishop & Clerk
SOUTH PACIFIC-Sheet 5
LAMBERT CONFORMAL CONIC PROJECTION
STANDARD PARALLELS 33° and 45°
100 200 300 400 500
STATUTE MILES
160 162 164 166 168 170 172 174 176 178 East 180 West 178
30 32 34 36 38 40 42 44 46 48 50 52 54
154 156 158 160 162 164 166 168 170 172
174 176 178 180 178 176 174

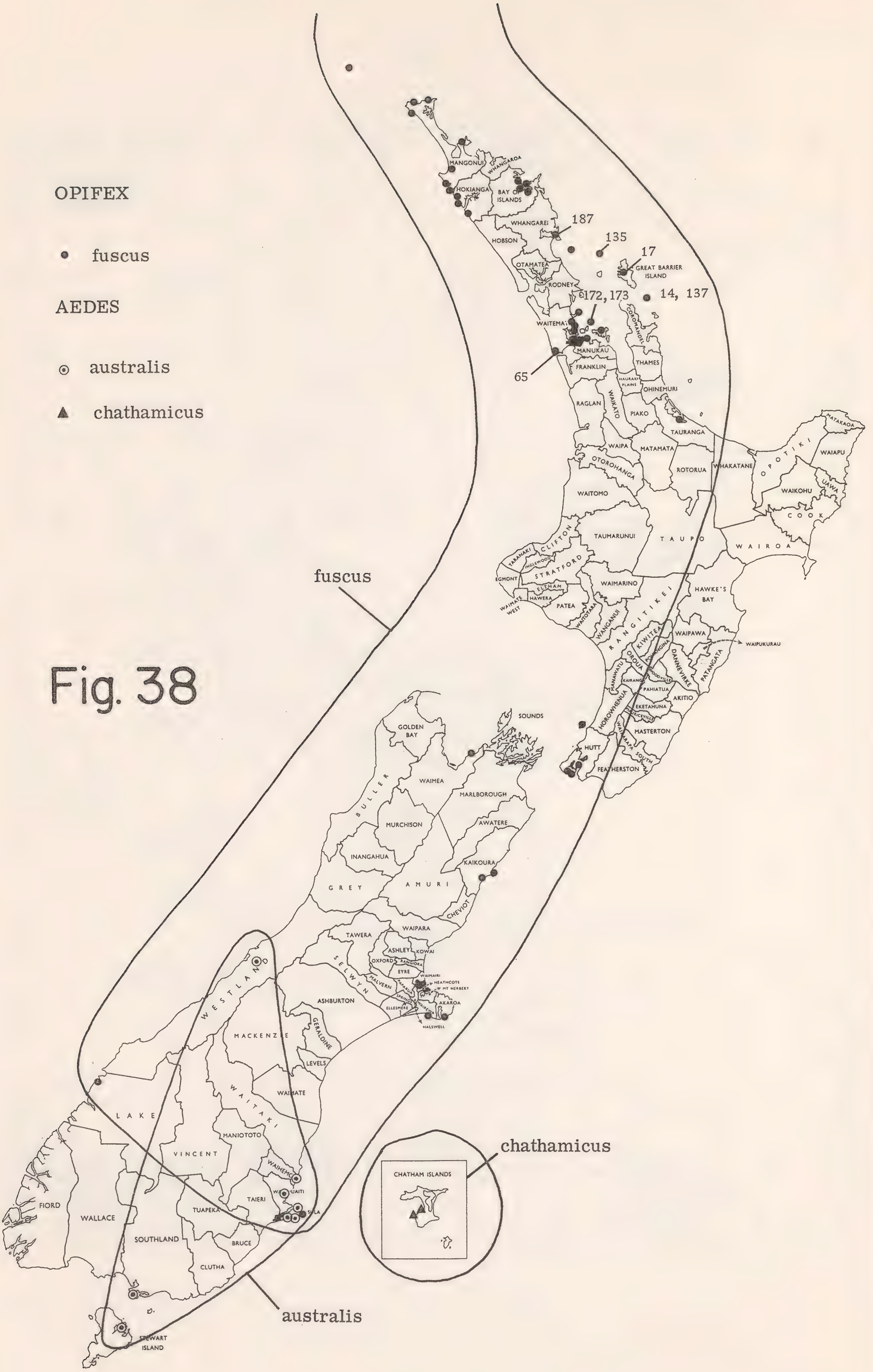

OPIFEX
● fuscus
AEDES
⊙ australis
▲ chathamicus
fuscus
australis
chathamicus
CHATHAM ISLANDS
187
135
17
14, 137
172, 173
65
GREAT BARRIER ISLAND
MANGONUI
WHANGAROA
HOKIANGA
BAY OF ISLANDS
WHANGAREI
HOBSON
OTAMATEA
RODNEY
WAITEMATA
MANUKAU
FRANKLIN
COROMANDEL
THAMES
HAURAKI PLAINS
OHINEMURI
RAGLAN
WAIKATO
PIAKO
TAURANGA
WAIPA
MATAMATA
ROTORUA
WHAKATANE
OPOTIKI
MATAKAOA
WAIAPU
UAWA
WAIKOHU
COOK
OTOROHANGA
WAITOMO
TAUMARUNUI
TAUPO
WAIROA
TARANAKI
CLIFTON
INGLEWOOD
STRATFORD
EGMONT
ELTHAM
HAWERA
WAIMATE WEST
PATEA
WAIMARINO
WANGANUI
WAITOTARA
RANGITIKEI
HAWKE'S BAY
KIWITEA
OROUA
POHANGINA
WAIPAWA
WAIPUKURAU
PATANGATA
DANNEVIRKE
MANAWATU
KAIRANGA
WOODVILLE
PAHIATUA
AKITIO
HOROWHENUA
EKETAHUNA
MAURICEVILLE
MASTERTON
HUTT
WAIRARAPA SOUTH
FEATHERSTON
SOUNDS
GOLDEN BAY
WAIMEA
BULLER
MARLBOROUGH
MURCHISON
AWATERE
INANGAHUA
KAIKOURA
GREY
AMURI
CHEVIOT
WAIPARA
TAWERA
ASHLEY
KOWAI
OXFORD
RANGIORA
EYRE
WAIMAIRI
HEATHCOTE
MT HERBERT
MALVERN
PAPARUA
SPRINGS
ELLESMERE
HALSWELL
AKAROA
SELWYN
ASHBURTON
WESTLAND
MACKENZIE
GERALDINE
LEVELS
WAIMATE
WAITAKI
LAKE
MANIOTOTO
VINCENT
WAIHEMO
WAIKOUAITI
TAIERI
PENINSULA
TUAPEKA
FIORD
WALLACE
SOUTHLAND
BRUCE
CLUTHA
STEWART ISLAND

Fig. 38

AEDES

● antipodeus

⊙ subalbirostris

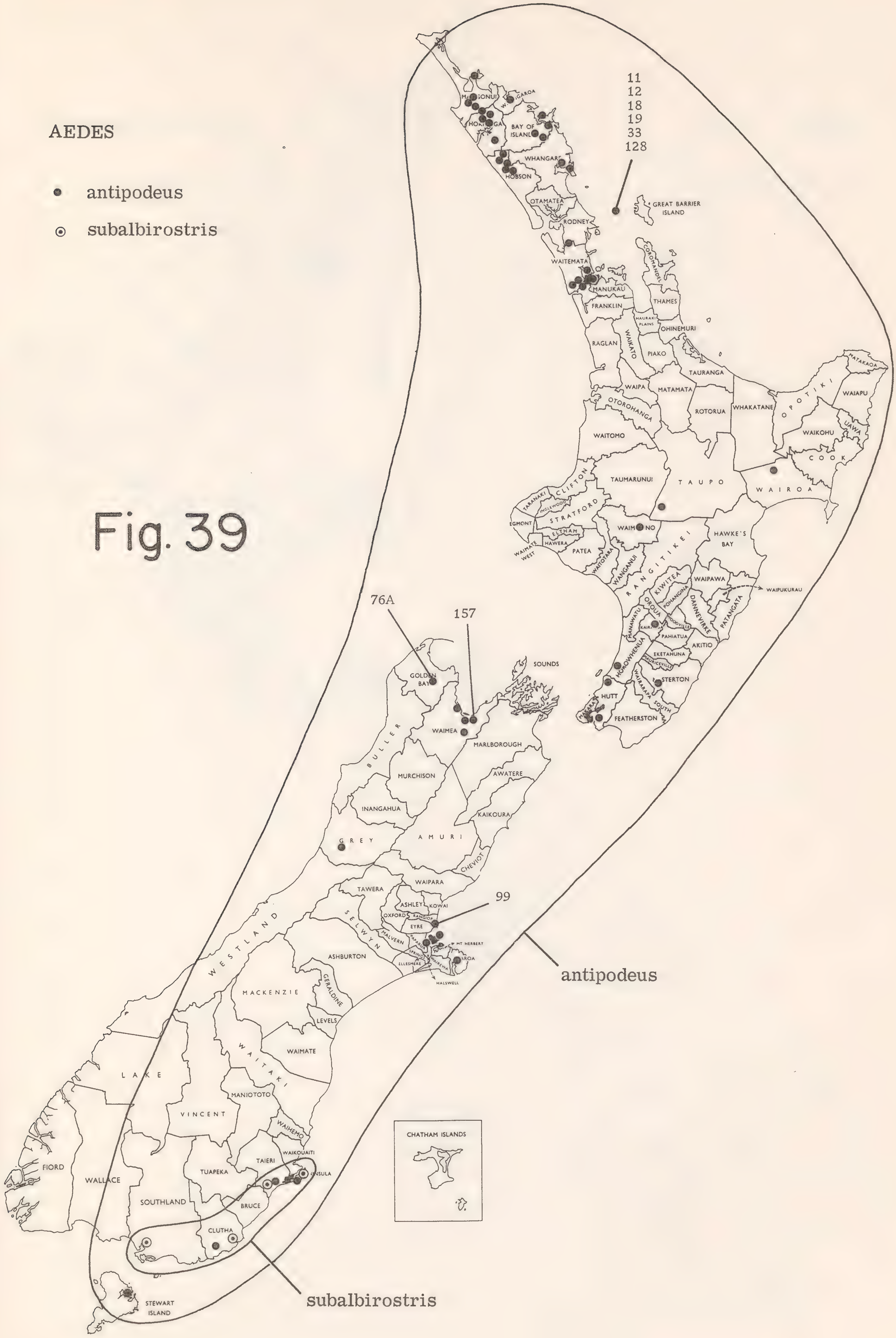


Fig. 39

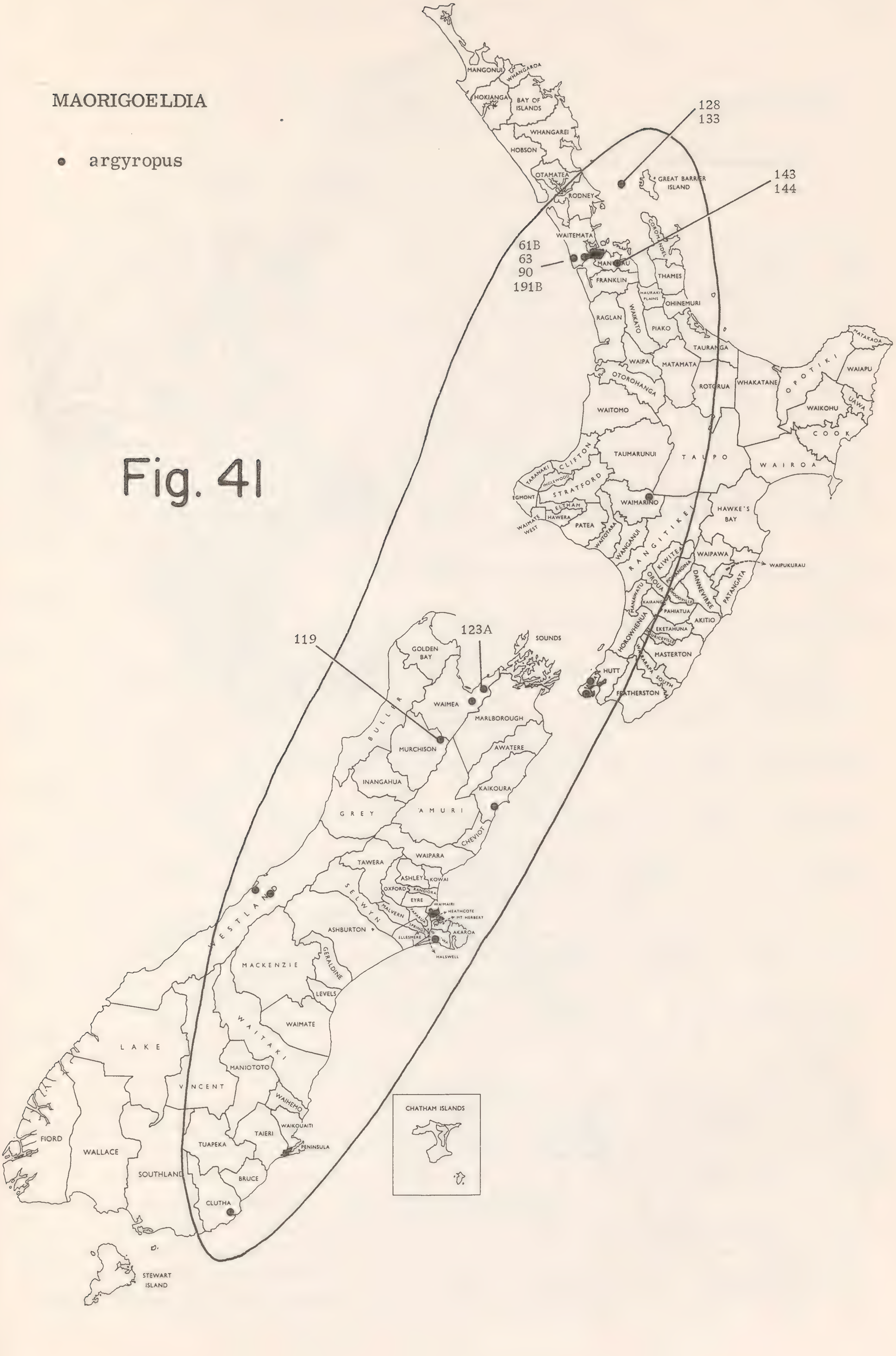

AEDES
● notoscriptus
37
38
128
129
130
222
67
68
59
60
61
63
89
91
92
95
191
194
200
142
47
MANGONUI
WHANGAROA
HOKIANGA
BAY OF ISLANDS
WHANGAREI
HOBSON
OTAMATEA
RODNEY
GREAT BARRIER ISLAND
COROMANDEL
WAITEMATA
MANUKAU
FRANKLIN
THAMES
HAURAKI PLAINS
OHINEMURI
WAIKATO
RAGLAN
PIAKO
TAURANGA
WAIPA
MATAMATA
ROTORUA
WHAKATANE
OPOTIKI
MATAKAOA
WAIAPU
UAWA
WAIKOHU
COOK
OTOROHANGA
WAITOMO
TAUMARUNUI
TAUPO
WAIROA
CLIFTON
TARANAKI
INGLEWOOD
STRATFORD
EGMONT
ELTHAM
HAWERA
WAIMATE WEST
PATEA
WAITOTARA
WAIMARINO
WANGANUI
RANGITIKEI
HAWKE'S BAY
WAIPAWA
WAIPUKURAU
KIWITEA
POHANGINA
DANNEVIRKE
PATANGATA
OROUA
MANAWATU
KAIRANGA
WOODVILLE
PAHIATUA
AKITIO
HOROWHENUA
EKETAHUNA
MAURICEVILLE
MASTERTON
WAIRARAPA SOUTH
HUTT
MAKARA
FEATHERSTON
SOUNDS
GOLDEN BAY
WAIMEA
MARLBOROUGH
BULLER
MURCHISON
AWATERE
INANGAHUA
KAIKOURA
GREY
AMURI
CHEVIOT
WAIPARA
TAWERA
ASHLEY
KOWAI
OXFORD
RANGIORA
EYRE
WAIMAIRI
HEATHCOTE
MT HERBERT
MALVERN
PAPARUA
SPRINGS
WAIREWA
AKAROA
ELLESMERE
HALSWELL
SELWYN
WESTLAND
ASHBURTON
GERALDINE
MACKENZIE
LEVELS
WAIMATE
WAITAKI
LAKE
MANIOTOTO
VINCENT
WAIHEMO
WAIKOUAITI
TAIERI
PENINSULA
FIORD
WALLACE
TUAPEKA
SOUTHLAND
BRUCE
CLUTHA
STEWART ISLAND
CHATHAM ISLANDS

Fig. 40

MAORIGOELDIA

● argyropus

Fig. 41



CORETHRELLA

● novaezealandiae

Fig. 42

APPENDIX A

NZ Collection Data

The bulk of the material on which this study is based was collected and reared following the methods later outlined by Belkin, Hogue et al (1965). This material is identified only by the following printed label: NZ [handwritten collection number from 1-225] 63//New Zealand 64//Belkin/Schroeder//. All the data pertinent to each collection (locality, date, collector, breeding site, rearing information, etc.) are entered on record cards deposited in the Department of Zoology, University of California, Los Angeles. These data are summarized in the following list under each collection number. Included are a few miscellaneous collections bearing this general label, which may not contain culicid material or were made by other individuals subsequent to the main survey. The following abbreviations are used for the names of collectors: B (J. N. Belkin); D (L. J. Dumbleton); E (R. Elliott); F (D. A. Forsyth); G (E. S. Gourlay); N (E. R. Nye); S (D. A. and M. R. Schroeder).

1. Epsom, Auckland, Golf Road (North Auckland), 21 Aug, S. On wall in house; 2000 hrs. Tipulid.

2. Waitomo Caves, 4 mi E (South Auckland), 24 Aug 63, S. On outside of car window; 1200 hrs. Chironomid.

3A. Kaiapoi, Pineacres Motel (Canterbury), 27 Aug 63, S. Inside bathroom; 1930 hrs. Chironomids.

3B. Kaiapoi, Pineacres Motel (Canterbury), 28 Aug 63, S. Inside bathroom; 0700 hrs. *Culex (C.) pervigilans*; chironomids.

4. Westport, Luxury Motel (Nelson), 28 Aug 63, S. On wall of bathroom; 2130 hrs. Chironomids.

5. Mt. Albert, Auckland, DSIR Laboratory (North Auckland), 10 Sept 63, A. Watson. In laboratory; 1100 hrs. Tipulid.

6. Rangitoto Island, Summit Track (North Auckland), elev. 177 m, 14 Sept 63, S. Cement container, 1 ft diameter, 3 ft deep; decaying vegetation; partial shade. *Aedes (F.) notoscriptus*.

7. Rangitoto Island (North Auckland), 14 Sept 63, S. Leaf axils of astelias (*Collospermum hastatum*) on ground in native bush; reddish brown water, partial shade. *Culex (C.) asteliae*; chironomid.

8. Rangitoto Island (North Auckland), 14 Sept 63, S. Old cement foundation for gun emplacement in native bush; fresh water with algae and decaying vegetation. *Aedes (F.) notoscriptus*.

9. Northcote, Clarence Road (North Auckland), elev. 12 m, 30 Sept 63, S. Metal tank, 5 ft diameter, 2.5 ft deep; greenish brown water with scum, algae and water lilies; partial shade. *Culex (C.) pervigilans*; chironomid.

10. Little Barrier Island, Ranger's house (Hauraki Gulf), elev. 6 m, 9 Oct 63, S. Metal pan, 2 ft diameter, 1 ft deep, 1.5 m above ground; clear water with leaves; partial shade. *Culex (C.) pervigilans*.

11. Little Barrier Island, small stream between Te Waikohare and Tirikikawa streams (Hauraki Gulf), elev. 7 m, 9 Oct 63, S. Stream bed pool with fresh water and no vegetation; partial shade in native bush. *Paradixa fuscinervis*; *Culex (C.) pervigilans*; *Aedes (O.) antipodeus*.

12. Little Barrier Island, Summit Track (Hauraki Gulf), elev. 267 m, 9 Oct 63, S. Ground pool, 12 x 3 ft; brownish fresh water with scanty grass on margins and decaying leaves; partial shade in native bush. Culex (C.) pervigilans; Aedes (O.) antipodeus.

13. Little Barrier Island, Summit Track (Hauraki Gulf), elev. 186 m, 10 Oct 63, S. Leaf axils of astelias growing on ground in native bush; water reddish brown, with decaying leaves; partial to deep shade. Culex (C.) asteliae.

14. Cuvier Island, Monument side (Hauraki Gulf), elev. 2 m, 24 Oct 63, S. Seaside seepage on rocky shore; water clear, fresh and with decaying vegetation; partial shade. Opifex fuscus.

15A, B. Great Barrier Island, Shoal Bay (Hauraki Gulf), on board M. V. Colville, 24-25 Oct 63, Captain Brown. Inside main cabin, at light (A), early morning (B). Tipulids.

16. Great Barrier Island, Shoal Bay (Hauraki Gulf), elev. 2 m, 25 Oct 63, S. Ditch along dirt road; clear fresh water with abundant scum, algae and grassy, floating and submerged vegetation; partial shade. Majority of larvae developed whitish growth around siphon and died. Culex (C.) pervigilans.

17. Great Barrier Island, mouth of Te Wairere stream (Hauraki Gulf), elev. 5 m, 26 Oct 63, S. Seaside rockhole with clear, slightly brackish water with some scum, algae and a few decaying leaves; partial shade. Culex (C.) pervigilans; Opifex fuscus.

18A, B, C. Little Barrier Island (Hauraki Gulf), elev. 7 m, 29 Oct (A), 7 Nov (B), 9 Nov (C) 63, S. Inside bunkhouse; 2000 hrs (A), daylight (B), 0630 hrs (C). Aedes (O.) antipodeus (A, C); mycetophilid (B).

19A, B. Little Barrier Island (Hauraki Gulf), elev. 7 m, 30 Oct (A), 1 Nov (B) 63, S. In lavatory of Ranger's house, 2230 hrs. Aedes (O.) antipodeus.

20. Little Barrier Island, between Lamb Bay Creek and Awaroa Stream (Hauraki Gulf), elev. 5 m, 31 Oct 63, S. Rocky stream bed pool near shoreline cliffs; clear fresh water with algae and decaying leaves; partial shade in native bush. Culex (C.) pervigilans.

21. Little Barrier Island, 0.25 mi up Awaroa stream (Hauraki Gulf), elev. ca 30 m, 31 Oct 63, S. Adults around boulders and along bank of stream bottom (no flowing water); 1430 hrs, partly cloudy.

22A. Little Barrier Island, about 0.25 mi up Awaroa Stream (Hauraki Gulf), elev. ca 30 m, 31 Oct 63, S. Adults found drowned on water surface of stream bed pool (same as 22B). Culex (C.) pervigilans.

22B. Little Barrier Island, about 0.25 mi up Awaroa Stream (Hauraki Gulf), elev. ca 30 m, 31 Oct 63, S. Rocky stream bed pool; water fresh and with algae; partial shade. Culex (C.) pervigilans.

23A. Little Barrier Island, 0.25 mi up Awaroa Stream, at junction of small tributary stream (Hauraki Gulf), elev. 30 m, 31 Oct 63, S. Adults swarming along bank behind stream bed pool of collection 23B; 1500 hrs; partly cloudy. Culex (C.) pervigilans.

23B. Little Barrier Island, 0.25 mi up Awaroa Stream, at junction of small tributary stream (Hauraki Gulf), elev. 30 m, 31 Oct 63, S. Stream bed pool with clear fresh water and decaying leaves; partial shade in native bush. Culex (C.) pervigilans.

24. Little Barrier Island, Summit Track (Hauraki Gulf), elev. 267 m, 8 Nov 63, S. Leaf axils of astelias growing on ground; water with decaying leaves; partial to deep shade in native bush. Culex (C.) asteliae.

25. Little Barrier Island, Summit Track (Hauraki Gulf), elev. 186 m, 8 Nov 63, S. Same site as collection 13. Leaf axils of epiphytic astelias (3.5 m

above ground); water reddish brown and with decaying leaves; partial shade in native bush. *Culex (C.) asteliae*.

26. Little Barrier Island, Summit Track (Hauraki Gulf), elev. 75 m, 8 Nov 63, S. Leaf axils of astelias growing on ground. *Culex (C.) asteliae*.

27. Cape Kidnappers (Hawke's Bay), elev. 66 m, 16 Nov 63, S. Stream bed pool with silty, turbid fresh water with slow current, abundant vegetation and mud bottom; full sunlight; sheep pasture. *Culex (C.) pervigilans*.

28. Ormond, Waimare Orchard (Gisborne), elev. 25 m, 17 Nov 63, S. Cemented fish pond with clear fresh water and abundant cultivated plants; partial shade. *Culex (C.) pervigilans*.

29. Near Okiore, 0.5 mi downstream from midway point in Waioeka Gorge (Gisborne), 19 Nov 63, S. Stream margin rockhole with clear fresh water, abundant algae and rocky and sandy bottom; full sunlight. *Culex (C.) pervigilans*.

30. Epsom, Auckland, Golf Road (North Auckland), 23 Nov 63, S. In rearing room, probably escaped from rearing vial.

31. Epsom, Auckland, Golf Road (North Auckland), 28 Nov 63, S. Landing on front porch, at light; 2300 hrs; cloudy night.

32. Epsom, Auckland, Golf Road (North Auckland), 1 Dec 63, S. At light on front porch, 2230 hrs; clear moonlit night; slight wind.

33. Little Barrier Island (Hauraki Gulf), 7 Nov 63, S. Collection record uncertain, probably as stated. *Aedes (O.) antipodeus*.

34. Little Barrier Island (Hauraki Gulf), elev. 7 m, 10 Oct 63, S. Inside lavatory of Ranger's house, at light, 2100-2300 hrs.

35. Waitakere Ranges, Quarry tributary of Waitakere River, at edge of Cascade Park, bridge at intersection (North Auckland), 18 Dec 63, BS. Stream margin; slow current; clear fresh water with abundant flotage and grassy vegetation; mud bottom; full sunlight. *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

36. Ruakaka, 1 mi S on highway 1 (North Auckland), 20 Dec 63, BS. Pond with clear fresh water; grassy vegetation abundant; mud bottom; full sunlight. *Paradixa fuscinervis*; *Culex (C.) pervigilans*; *Coquillettidia (C.) iracunda*.

37. Opua, 3 mi S of turnoff on Kawakawa-Paihia road (North Auckland), 20 Dec 63, BS. Small treeholes in mangrove (*Avicennia*) with dark reddish brown water; holes from a few inches to 1 ft above high tide level; water apparently fresh. *Aedes (F.) notoscriptus*.

38. Opua, 3 mi S of turnoff on Kawakawa-Paihia road (North Auckland), 20 Dec 63, BS. Small treeholes in mangrove (*Avicennia*) with dark reddish brown water, apparently fresh; holes 2-2.5 ft above high tide level. *Culex (C.) pervigilans*; *Aedes (F.) notoscriptus*.

39. Kaeo, 3 mi S on highway 10 (North Auckland), 20 Dec 63, BS. Small pool in ditch along highway; fresh, turbid, milky water without vegetation; mud bottom; partial shade. *Culex (C.) pervigilans*.

40. Mangamuka Gorge, 4 mi N of Soda Spring, NW drainage near top of pass (North Auckland), 21 Dec 63, BS. Leaf axils of broad-leaved astelias (1-3 m above ground); water brownish; mud in axils; partial shade. No mosquitoes; chironomids present.

41. Mangamuka Gorge, 2 mi N of Soda Spring (North Auckland), 21 Dec 63, BS. Stream bed pool along moderately fast-flowing stream; clear fresh water without vegetation; clay bottom; partial shade. *Nothodixa campbelli*; *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

42. Mangamuka Gorge, 2 mi N of Soda Spring (North Auckland), 21 Dec 63,

BS. Margins of moderately fast-flowing stream, larvae on banks; clear fresh water without vegetation; clay bottom; partial shade. *Paradixa neozelandica*; *P. fuscinervis*.

43. Waipoua Forest, 1-2 mi N of Big Tree (North Auckland), 21 Dec 63, BS. Leaf axils of epiphytic astelias (1-2 m above ground); water brownish; axils with mud and decaying leaves and twigs; partial shade. Chironomids; mosquitoes absent.

44. Waipoua Forest, Big Tree Roadside Park (North Auckland), 21 Dec 63, BS. Three separate holes in large tree stump near rest rooms, about 1.5 m above ground; water reddish brown; partial shade. One small mosquito larva seen but lost.

45. Oratia, DSIR Field Station (North Auckland), 22 Dec 63, BS. Fire drum with 6 in of rusty water; full sunlight. *Paradixa fuscinervis*; *Culex (C.) pervigilans*.

46. Rotorua, Kuirau Hot Springs Reserve (South Auckland), 23 and 27 Dec 63, BS. Pools and outflow ditch from hot springs; temperature 27-28°C; water turbid and with moderate current; vegetation scanty to none, herbaceous; mud bottom; full sunlight. *Paradixa fuscinervis* (probably contamination); *Culex (C.) rotoruae*.

47. Ormond, Waihirere Domain (Gisborne), 25 and 26 Dec 63, BS. Small treehole in *Leptospermum ericoides* tree; dark reddish brown water; bottom with decaying vegetation; partial shade. *Aedes (F.) notoscriptus*.

48. Ormond, Waihirere Domain (Gisborne), 25 and 26 Dec 63, BS. Stream margin and pools above swimming pool to falls; current moderate; water clear and fresh; flotage abundant, vegetation scanty; mud bottom; partial shade. Larvae frequently on leaves floating in stream pools or on banks of stream. *Paradixa neozelandica*; *P. fuscinervis*.

49. Ormond, Waihirere Domain (Gisborne), 26 Dec 63, BS. Axils of epiphytic astelias (3-4 m above ground) on upper part of path to falls; water brownish; partial to deep shade in native bush. No mosquitoes.

50. Hexton, at bridge H20, S16-41 (Gisborne), 26 Dec 63, BS. Grassy stream margins; water clear to turbid, fresh; current moderate; vegetation scanty; mud bottom; full sunlight. *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

51. Terapatiki (Gisborne), 27 Dec 63, BS. Margins of small stream; current moderate to strong; water fresh and clear; vegetation scanty; rock bottom; full sunlight. *Paradixa fuscinervis*.

52. Urewera National Park, Aniwaniwa Falls (Gisborne), 27 Dec 63, BS. Stream pool below upper falls; current moderate; water fresh and clear; vegetation scanty, flotage abundant; gravel and rock bottom; partial to full sunlight. *Paradixa fuscinervis*.

53. Urewera National Park, Aniwaniwa Falls (Gisborne), 27 Dec 63, BS. Leaf axils of *Cordyline australis* (at 2.5 to 3 m above ground) on path to falls; water turbid; partial shade. Ceratopagonids abundant.

54. Urewera National Park, Aniwaniwa Falls (Gisborne), 27 Dec 63, BS. Leaf axils of epiphytic astelias (at 2-3 m above ground) on path to falls; water brownish; partial to deep shade. Chironomids abundant.

55. Urewera National Park, near Mokau Falls (Gisborne), 27 Dec 63, BS. Blocked road ditch, probably fed by seepages, along main road, current slow; water brownish, fresh; grassy vegetation and flotage scanty; mud bottom; full sunlight. *Paradixa fuscinervis*; *Culex (C.) pervigilans*.

56. Urewera National Park, Hopuruahine area (Gisborne), elev. ca 2900 ft,

27 Dec 63, BS. Margins of small stream; current strong; water clear and fresh; scanty grassy vegetation; gravel and rock bottom; deep shade. *Nothodixa septentrionalis*.

57A. Waitakere Ranges, Bethells Road Swamp, near mouth of Waitakere River (North Auckland), 28 and 29 Dec 63, BFS. Edge of swamp. Biting-landing and sweeping collection; 1130-1445 hrs; sunny, warm and windy. *Coquillettidia (A.) tenuipalpis*; *C. (C.) iracunda*.

57B. Waitakere Ranges, Bethells Road Swamp, near mouth of Waitakere River (North Auckland), 28 and 29 Dec 63, BFS. Shallow water along edge of swamp; water stagnant, fresh, brownish; vegetation very dense, primarily *Typha*, *Juncus*, *Scirpus* and sedges; bottom with mud and decaying vegetation; full sunlight. *Coquillettidia (A.) tenuipalpis*; *C. (C.) iracunda*.

58. Waitakere Ranges, Quarry tributary of Waitakere River, at edge of Cascade Park, downstream of bridge at intersection (North Auckland), same location as collection 35 but farther downstream, 28 Dec 63, BF. Stream margin; slow current; clear fresh water with abundant flotage and grassy vegetation; mud bottom; deep shade. *Paradixa fuscinervis*.

59. Waitakere Ranges, Quarry tributary of Waitakere River, at edge of Cascade Park, downstream of bridge at intersection (North Auckland), same location at collection 35 but farther downstream, 28 Dec 63, BF. Biting-landing in dense shade along stream banks. *Coquillettidia (C.) iracunda*; *Aedes (F.) notoscriptus*.

60. Waitakere Ranges, Quarry tributary of Waitakere River, at edge of Cascade Park, downstream of bridge at intersection (North Auckland), same location as collection 35 but farther downstream, 28 Dec 63, BF. Leaf axils of terrestrial astelias; water turbid, brownish; axils with mud; deep shade. *Aedes (F.) notoscriptus*; chironomids.

61A. Titirangi Beach, end of Mahoe Road (North Auckland), 30 Dec 63, BF. Adults biting-landing on collectors near breeding sites (61B); 1030-1130 hrs; intermittent rain. *Aedes (F.) notoscriptus*.

61B. Titirangi Beach, end of Mahoe Road (North Auckland), same location and time as 61A, 30 Dec 63, BF. Tin cans and tire; water brownish; bottom with decaying vegetation; deep shade. *Aedes (F.) notoscriptus*; *Maorigoeldia argyropus*.

62. Titirangi Beach, end of Mahoe Road (North Auckland), 30 Dec 63, BF. Leaf axils of epiphytic astelias (3-4 m above ground); water brown, turbid; bottom with mud; deep shade. Mosquitoes absent.

63. Titirangi Beach, end of Mahoe Road (North Auckland), 30 Dec 63, BF. Tin cans; water rusty, brown; deep shade. *Aedes (F.) notoscriptus*; *Maorigoeldia argyropus*.

64. Titirangi Beach, creek above dam (North Auckland), 30 Dec 63, BF. Margins of dammed creek; water fresh, clear; vegetation herbaceous, scanty; flotage abundant; mud bottom; partial to deep shade. *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

65. Little Huia, west of point beyond pier (North Auckland), 30 Dec 63, BF. Cavity in dead horizontal trunk of pohutukawa tree projecting over high tide level; water turbid, brackish; some flotage and decaying vegetation; full sunlight. *Opifex fuscus*.

66. Oratia, DSIR Field Station (North Auckland), same site as collection 45, 30 Dec 63, S. Fire drum with 6 in of rusty water; full sunlight. *Paradixa fuscinervis*; *Culex (C.) pervigilans*; *C. (C.) quinquefasciatus*.

67. Rangitoto Island (North Auckland), 4 Jan 64, S. Leaf axils of astelias

(*Collospermum hastatum*) growing on lava flow near the sea; water reddish brown, fresh; axils with decaying leaves and twigs; partial shade. *Culex (C.) asteliae*; *Aedes (F.) notoscriptus*.

68. Rangitoto Island (North Auckland), 7 Jan 64, BS. Leaf axils of astelias (*Collospermum hastatum*) growing on periphery of clumps of vegetation on lava flow (farther from shore than collection 67); water light reddish brown, fresh; axils with some decaying leaves and twigs; full sunlight to partial shade. *Culex (C.) asteliae*.

69. Rangitoto Island, wharf (North Auckland), 7 Jan 64, BS. Cistern at swimming pool; larvae in cistern cover and air hole. *Culex (C.) quinquefasiatus*.

70. Hooper's Inlet, sea side of road on western shore of inlet (Otago), 2 Jan 64, BN. Ditch in saltmarsh; water salty; vegetation scanty, herbaceous; sand bottom; full sunlight. *Aedes (H.) australis*.

71. Hooper's Inlet, inland side of road on western shore of inlet (Otago), 2 Jan 64, BN. Ditch in cultivated field; water brackish; abundant herbaceous vegetation and flotage; mud bottom; full sunlight. *Culex (C.) pervigilans*.

72. Governors Bay, Lyttelton Harbour (Canterbury), 3 Jan 64, BD. Margins of small stream; current moderate; water clear and fresh; scanty herbaceous vegetation, abundant flotage; rock bottom; partial to full sunlight; larvae primarily in flotage. *Nothodixa campbelli*; *Paradixa fuscinervis*.

73A. Nelson, stream across from Gourlay's home (Nelson), 3 Jan 64, BG. Sweeping vegetation on banks of stream (same as 73B); most abundant 1930-2000 hrs. *Paradixa neozelandica*; *P. fuscinervis*.

73B. Nelson, stream across from Gourlay's home (Nelson), 3 Jan 64, BG. Margins of stream; slow to moderate current; water clear and fresh; vegetation and flotage scanty; mud bottom; partial to full sunlight. *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

74A. North Branch Riwaka River, Crystal Pool, just below source (Nelson), 4 Jan 64, BG. Female under overhanging rock, above breeding sites (collection 74B). *Paradixa fuscinervis*.

74B. North Branch Riwaka River, Crystal Pool, just below source (Nelson), 4 Jan 64, BG. Stream pool; current slow; water clear and fresh; scanty herbaceous vegetation and flotage; rock bottom; partial shade. *Paradixa fuscinervis*.

75. North Branch Riwaka River, large bridge just below fords over small streams before source of river (Nelson), 4 Jan 64, BG. Stream margins; moderate to strong current; water clear and fresh; scanty herbaceous vegetation and flotage; gravel and rock bottom; partial shade. *Nothodixa* only along very small branch of stream, not over 1 ft in width, very shallow; primarily in shade and largely out of water. *Nothodixa campbelli*; *Paradixa fuscinervis*; *Culex (C.) pervigilans*.

76A. Canaan Beech Forest (Nelson), 4 Jan 64, BG. Adults landing in clearing of beech forest; 1200-1300 hrs (same general location as 76B). *Aedes (O.) antipodeus*.

76B. Canaan Beech Forest (Nelson), 4 Jan 64, BG. Tiny treeholes in young *Nothofagus*, probably formed at sites of former branches of saplings; height about 1.2 m; water very dark reddish brown, very scanty; deep shade. Mosquitoes absent.

77. Canaan Beech Forest, Harwood's Hole Track (Nelson), 4 Jan 64, BG. Sphagnum bog with moderately large open pond in center; water brownish; abundant *Sphagnum*, *Scirpus* and *Juncus* and flotage; mud bottom; partial to

full sunlight. *Culex (C.) pervigilans*.

78. Canaan Beech Forest, Harwood's Hole Track (Nelson), 4 Jan 64, BG. Large pond with sphagnum along margins only; water a light brown; mud bottom; partial to full sunlight. *Culex (C.) pervigilans*.

79. Aniseed Valley, Roding River, first ford below Roding ford (Nelson), 5 Jan 64, BG. Rivulet not over 2 ft in width; margins and pools; slow to moderate current; fresh clear water; scanty vegetation and abundant flotage; from deep shade to full sunlight. Larvae of *Nothodixa* and *Paradixa* together in flotage in dense shade and in the open in watercress. *Nothodixa campbelli*; *Paradixa fuscinervis*.

80. Aniseed Valley, Roding River, third ford below Roding ford (Nelson), 5 Jan 64, BG. Separate stream pools with slight flow in bed of rivulet; water fresh and clear; scanty herbaceous vegetation and algae, abundant flotage; sand and gravel bottom; deep shade to full sunlight. *Nothodixa* and *Paradixa* together in all situations. *Nothodixa campbelli*; *Paradixa neozelandica*; *P. fuscinervis*.

81. Waitakere Ranges, West Coast Road, first stream west of Scenic Drive (North Auckland), 8 Jan 64, BES. Stream margins; current slow to moderate; water clear and fresh; vegetation and flotage scanty; gravel bottom; partial to full sunlight. *Paradixa fuscinervis*.

82. Waitakere Ranges, Karekare Road at crossing of headwaters of Opal Pools (North Auckland), 8 Jan 64, BES. Leaf axils of epiphytic astelias (*Collospermum hastatum*) on blown-down tree (2 m from ground); water light brownish; partial to deep shade. *Culex (C.) asteliae*.

83. Ohakune, Mt. Road, first stream below first bridge (Wellington), 9 Jan 64, BFS. Margins of stream dammed above culvert; moderate to strong current; water clear, brownish; scanty fern vegetation and flotage; mud bottom; partial shade. *Paradixa neozelandica*; *P. fuscinervis*; *P. harrisi*.

84. Ohakune, Rangataua Reserve Lake (Wellington), 9 Jan 64, BFS. Margins of lake; water clear and light brownish; abundant herbaceous vegetation; mud bottom; full sunlight. *Paradixa fuscinervis*; *Culex (C.) pervigilans*.

85A. Ohakune, pond on bend of Lake Road, south of Rangataua Reserve Lake (Wellington), 9 and 10 Jan 64, BFS. Adults swept in grassy and shrubby area around lake; very cold and windy, air temperature less than 50°F; 0815-1015, 1700, 1930-2000 hrs. *Coquillettidia (A.) tenuipalpis*.

85B. Ohakune, pond on bend of Lake Road, south of Rangataua Reserve Lake (Wellington), 9 and 10 Jan 64, BFS. Margins of lake; water clear and light brown; abundant herbaceous vegetation (*Scirpus*, *Juncus*) and flotage; mud bottom; full sunlight. Larvae primarily in clumps of vegetation. *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

86. Pokaka, culverts between old and new roads (Wellington), 10 Jan 64, BFS. Stream pool between 2 culverts; moderate current; water clear and brownish; scanty herbaceous vegetation and flotage; mud bottom; full sunlight. *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

87. Pokaka, small creek through pasture along main road (Wellington), 10 Jan 64, BFS. Stream margins; moderate to strong current; water clear and brownish; scanty herbaceous vegetation and flotage; mud and sand bottom; full sunlight. *Paradixa fuscinervis*.

88. Te Aroha, stream at head of main EW street (South Auckland), 10 Jan 64, BFS. Stream margin; current moderate to strong; water clear; flotage scanty; sand and gravel bottom; deep shade. One dixine larva, apparently lost.

89. Titirangi Beach, end of Mahoe Road (North Auckland), same locality

as collections 61-63, 11 Jan 64, BS. Biting-landing in shaded area across road from houses; 1500-1700 hrs; raining, cool. *Aedes (F.) notoscriptus*.

90. Titirangi Beach, end of Mahoe Road (North Auckland), same locality as collections 61-63, 89, 11 Jan 64, BS. Two males flying around trunk of *Leptospermum ericoides* tree, apparently disturbed when trees looked over for rotholes; 1600-1700 hrs; raining. *Maorigoeldia argyropus*.

91. Titirangi Beach, end of Mahoe Road (North Auckland), same locality as collections 61-63, 89, 90, 11 Jan 64, BS. Paint can, tire and tin cans; water turbid and brownish; deep to partial shade. *Aedes (F.) notoscriptus*.

92. Titirangi Beach, end of Mahoe Road (North Auckland), same locality as collections 61-63, 89-91, 11 Jan 64, BS. Small rotholes in *Leptospermum ericoides*, *Nothopanax simplex* and *Pseudopanax crassifolium* at height of 1-2 m above ground; water dark reddish brown; partial to deep shade. *Aedes (F.) notoscriptus*.

93. Titirangi Beach, end of Mahoe Road (North Auckland), same locality as collection 61-63, 89-92, 11 Jan 64, BS. Leaf axils of epiphytic astelias (*Collospermum hastatum*) at 3-4 m above ground; water brownish; axils with mud; partial shade. *Culex (C.) asteliae*; *C. (C.) quinquefasciatus* (possibly contamination in laboratory).

94. Titirangi Beach, creek above dam (North Auckland), same locality as collection 64, 11 Jan 64, BS. Margins of dammed creek; slow current; water fresh and turbid; scanty herbaceous vegetation; abundant flotage; mud bottom; partial shade. *Paradixa neozelandica*; *P. fuscinervis*; *P. harrisi*.

95. Titirangi, South Titirangi Road at beach (South Auckland), 11 Jan 64, BS. Beached boat with small amount of brownish water; partial shade. *Aedes (F.) notoscriptus*.

96. Dunedin, Botanical Gardens (Otago), 2 Jan 64, BN. Ornamental pond with clear water; abundant herbaceous vegetation and flotage; mud bottom; partial shade. *Paradixa fuscinervis*.

97. Waitakere Ranges, 0.25 mi S from main turnoff to Karekare from West Coast (Piha) Road (North Auckland), 14 Jan 64, S. Roadside ditch; water fresh and turbid; algae present; mud bottom; full sunlight. *Culex (C.) pervigilans*.

98. Waitakere Ranges, West Coast (Piha) Road, stream east of inlet to Nihotupu Reservoir (North Auckland), 14 Jan 64, S. Margins of stream 6-8 ft wide; current moderate; water clear and fresh; algae present; rock bottom; partial to deep shade. *Paradixa fuscinervis*.

99. Kaiapoi, Pineacres Motel (Canterbury), 21 Jan 64, S. Adults resting inside motel room, primarily bathroom; 1900 hrs. *Culex (C.) pervigilans*; *Aedes (O.) antipodeus*.

100. Timaru, Scenic Reserve (Canterbury), 24 Jan 64, S. Margins of large ground pool; water clear and fresh; abundant flotage, grassy and herbaceous vegetation, scum and algae; mud and decaying leaves on bottom; partial shade. *Paradixa neozelandica*; *Culex (C.) pervigilans*.

101. Makikihi, 3 mi N of town (Canterbury), 25 Jan 64, S. Margins of small stream; fresh, clear water; abundant grassy vegetation; mud bottom, full sunlight. *Culex (C.) pervigilans*.

102. Waianakarua River, near bridge of main road (Otago), 25 Jan 64, S. Stream margins; slow current; clear water; abundant grassy vegetation and algae; gravel and decaying vegetation on bottom; partial shade. *Paradixa neozelandica*; *P. fuscinervis*; *P. tonnoiri*.

103. Clinton, 6 mi N (Otago), 26 Jan 64, S. Stream margins; moderate

current; water fresh and clear; abundant grassy vegetation; partial shade. *P. fuscinervis*.

104. Bluff (Southland), 26 Jan 64, S. Seaside rockholes; water clear, reddish and slightly salty; scanty algae; mud, gravel and rock bottom; partial to full sunlight. *Culex (C.) pervigilans*; *Aedes (H.) australis*.

105. Oban, road to Observation Rock (Stewart Island), 27 Jan 64, S. Ditch with muddy water; partial shade. *Culex (C.) pervigilans*.

106. Oban, Golden Bay at north entrance to Paterson Inlet (Stewart Island), 27 Jan 64, S. Large ground pool under rock crusher; scanty vegetation, flotage, scum and algae; mud bottom with decaying vegetation; partial shade. *Culex (C.) pervigilans*; *Aedes (H.) australis*.

107. Between Invercargill and Bluff, just N of Awarua Radio Station (Southland), 28 Jan 64, S. Margins of large ground pool in sheep pasture; water fresh, turbid, brownish; scanty grassy vegetation; mud bottom; full sunlight. *Culex (C.) pervigilans*.

108. Between Invercargill and Bluff, just N of fertilizer plant (Southland), 28 Jan 64, S. Flooded pasture; water fresh, turbid, brownish; abundant herbaceous, grassy and floating vegetation, also scum and algae; mud bottom; full sunlight. *Culex (C.) pervigilans*.

109A. Black Gully, 2.5 mi S of Crookston (Otago), 31 Jan 64, S. Sweeping along stream margin; in beech forest. No mosquitoes.

109B. Black Gully, 2.5 mi S of Crookston (Otago), 31 Jan 64, S. Stream margin; moderate to strong current; fresh, clear water; gravel bottom, partial shade; in beech forest. *Nothodixa campbelli*; *Paradixa fuscinervis*.

110. Te Anau (Southland), 2 Feb 64, S. Flooded pasture; grassy vegetation; mud bottom; full sunlight. *Culex (C.) pervigilans*.

111. Queenstown, Ben Lomond (Otago), 2 Feb 64, S. Stream with abundant watercress and grass; current slow; water clear and fresh; mud bottom; partial shade. Larvae clinging to watercress at water level. *Paradixa neozelandica*; *P. fuscinervis*.

112. Lake Mapourika (Westland), 7 Feb 64, S. Adults biting just after dark; weather clear. *Culiseta (C.) tonnoiri*; *Coquillettidia (C.) iracunda*.

113. Waiho vicinity (Westland), 7 Feb 64, S. Large ground pool in pasture; water fresh and clear. *Culex (C.) pervigilans*.

114. Whataroa, 1 mi S of Waitangi River on main S road (Westland), 7 Feb 64, S. Large ground pool with clear fresh water and scanty vegetation; mud and decaying vegetation on bottom; partial shade. *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

115. Hercules Mt vicinity, 7-8 mi S of Harihari on route 6 (Westland), 7 Feb 64, S. Margin of stream pool; slow current; water clear; scanty grassy vegetation, flotage, scum and algae present; mud bottom; full sunlight. *Paradixa neozelandica*; *P. fuscinervis*; *P. tonnoiri*; *Culex (C.) pervigilans*.

116. New Creek Rd, between Murchison and Kawatiri Junction (Nelson), 8 Feb 64, S. Stream pool; slow current; scanty grassy vegetation; sand and rock bottom; partial shade. *Nothodixa campbelli*; *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

117A. Lake Rotoiti, very small stream above campground (Nelson), 9 Feb 64, S. Sweeping in virgin *Nothofagus* forest; 1100 hrs; clear and sunny. No mosquitoes.

117B. Lake Rotoiti, very small stream above campground (Nelson), 9 Feb 64, S. Stream margin; slow current; water clear and fresh; scanty grassy vegetation; gravel and mud bottom; partial to deep shade. *Paradixa fuscinervis*.

118. Lake Rotoiti, campground (Nelson), 9 Feb 64, S. Small treehole in *Nothofagus*; height 1-2 m; reddish brown water with decaying vegetation on bottom; partial shade. No mosquitoes.

119. Lake Rotoiti, above campground (Nelson), 9 Feb 64, S. Large treehole in *Nothofagus*; height 0.3 m; greenish-yellow water; decaying vegetation on bottom; partial to deep shade. *Maorigoeldia argyropus*.

120. Kawatiri Junction, junction of Buller and Hope roads (Nelson), 9 Feb 64, S. Large ground pool; water clear; abundant herbaceous and grassy vegetation; gravel bottom; full sunlight. *Culex (C.) pervigilans*.

121. Gowan River on way to Lake Rotorua (Nelson), 9 Feb 64, S. Stream margin; slow current; water clear; abundant grass and watercress, also algae; mud bottom; partial shade. *Paradixa neozelandica*; *Culex (C.) pervigilans*.

122. Gowanbridge, near junction of Buller and Gowan rivers (Nelson), 9 Feb 64, S. Large ground pool in seepage area; slow current; water fresh and clear; abundant watercress; mud bottom; partial shade. *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

123A. Nelson, North Branch Maitai River (Nelson), elev. ca 130 m, 11 Feb 64, S. Sweeping along banks of small stream and resting on *Nothofagus* trunk. *Maorigoeldia argyropus*.

123B. Nelson, North Branch Maitai River (Nelson), elev. ca 130 m, 11 Feb 64, S. Margin of stream; slow current; fresh, clear water; vegetation very scanty; gravel and rock bottom; deep shade. *Paradixa fuscinervis*.

124. Nelson, Cawthron Park (Nelson), elev. ca 150 m, 11 Feb 64, S. Small ground pool in seepage; slow current; clear, fresh water; scanty vegetation; mud and decaying vegetation on bottom; partial to deep shade. *Paradixa fuscinervis*.

125. Nelson, junction of Maitai River and Sclanders stream (Nelson), 11 Feb 64, S. Stream margin and stream pools; slow current; clear, fresh water; scanty vegetation, scum and algae; mud and decaying vegetation on bottom; partial shade in *Nothofagus* forest. *Nothodixa campbelli*; *Paradixa fuscinervis*; *Culex (C.) pervigilans*.

126. Nelson, South Branch Maitai River (Nelson), 11 Feb 64, S. Small ground pool in seepage; scum present. *Culex (C.) pervigilans*.

127. Nelson, South Branch Maitai River (Nelson), 11 Feb 64, S. Margins of small stream flowing into river; scanty watercress and grassy vegetation; mud and sand bottom; partial shade. *Nothodixa campbelli*; *Paradixa fuscinervis*.

128. Little Barrier Island, small stream between Te Waikohare and Tirikikawa streams (Hauraki Gulf), elev. 7 m, 6 Mar 64, S. Separate pools in almost dry stream bed. *Nothodixa campbelli*; *Culex (C.) pervigilans*; *Aedes (O.) antipodeus*; *Aedes (F.) notoscriptus*; *Maorigoeldia argyropus*.

129. Little Barrier Island, near chicken house (Hauraki Gulf), elev. 7 m, 6 Mar 64, S. Small artificial container with brownish fresh water. *Culex (C.) pervigilans*; *Aedes (F.) notoscriptus*.

130. Little Barrier Island, Waipawa stream, 75-100 ft from mouth (North Auckland), 6 Mar 64, S. Separate pools in dry stream bed; clear stagnant water; scanty grassy vegetation and flotage; bottom with decaying leaves; partial shade. *Paradixa neozelandica*; *P. fuscinervis*; *P. harrisi*; *Culex (C.) pervigilans*; *Aedes (F.) notoscriptus*.

131. Little Barrier Island, Tirikikawa stream (Hauraki Gulf), elev. 30 m, 8 Mar 64, S. Separate pools in nearly dry stream bed; slow current; fresh clear water; some flotage; decaying vegetation on bottom; partial shade. *Paradixa fuscinervis*; *P. harrisi*; *Culex (C.) pervigilans*.

132. Little Barrier Island, Summit Track (Hauraki Gulf), elev. 225 m, 7 Mar 64, S. Leaf axils of terrestrial astelias (?Collospermum hastatum). Culex (C.) asteliae.

133. Little Barrier Island, Summit Track (Hauraki Gulf), elev. 250 m, 7 Mar 64, S. Treehole in Nothofagus, 2 x 3 in; water brownish; in virgin forest. Maorigoeldia argyropus.

134. Little Barrier Island, Hut Bay Creek (Hauraki Gulf), near sea level, 8 Mar 64, S. Stream margins and pools; slow current; clear water; some flotage; decaying vegetation on bottom; partial shade. Paradixa neozelandica; P. fuscinervis; P. harrisi.

135. Mokohinau Island (Hauraki Gulf), on shipboard, 11 Mar 64, S. Females on human bait; 1630 hrs; windy. Island mostly cleared, numerous rockpools. Opifex fuscus.

136. Cuvier Island (Hauraki Gulf), 13 Mar 64, S. Ground pool. Culex (C.) pervigilans.

137. Cuvier Island, 13 Mar 64, S. Seaside volcanic rockhole; water brackish; mud bottom; partial shade. Opifex fuscus.

138. Great Barrier Island, Port Fitzroy (Hauraki Gulf), 12 Mar 64, S. Stream margins. Nothodixa campbelli; Paradixa neozelandica; P. fuscinervis; P. harrisi.

139. Te Aroha, Stoney Creek (South Auckland), 26 Mar 64, S. Stream margin; slow to moderate current; clear, fresh water; no vegetation or flotage; gravel and rock bottom; partial shade. Nothodixa campbelli; N. septentrionalis.

140. Ormond, Waihirere Domain (Gisborne), 28 Mar 64, S. Stream margins and pools below falls; slow current; clear, fresh water; scanty grassy vegetation; partial shade. Paradixa neozelandica; P. fuscinervis; Culex (C.) pervigilans.

141. Urewera National Park, Hopuruahine area, Orangihikoa Stream (Gisborne), elev. 2450 ft, 30 Mar 64, S. Stream margin; moderate current; clear, fresh water; scanty grassy vegetation. Nothodixa campbelli; N. septentrionalis; Paradixa fuscinervis.

142. Te Puke, Prew Orchard, #3 road (South Auckland), 31 Mar 64, S. Cement water basin, 3 ft diameter, 1 ft deep; bottom with decaying pine needles; partial shade. Culex (C.) pervigilans; Aedes (F.) notoscriptus.

143. Clevedon (North Auckland), 5 Apr 64, S. Metal cooking pan, 1 ft sq, 3 in high; rusty water; decaying leaves and twigs on bottom; partial shade in native bush. Maorigoeldia argyropus.

144. Clevedon (North Auckland), 5 Apr 64, S. Tire; mud and decaying vegetation on bottom; partial to deep shade in native bush. Maorigoeldia argyropus.

145-149. No collections.

150. Chatham Island, Te Awarakau near Waitangi, elev. 4 m, 25 Feb, S. Large seaside rockpools and seepages; slow current; water fresh to salty; scanty flotage and algae; sand and rock bottom with decaying vegetation; full sun. See also 155. Aedes (N.) chathamicus.

151. Chatham Island, road near flying boat base, 26 Feb 64, S. Large ground pool; yellowish fresh water; abundant flotage and algae; mud bottom; full sun. Culex (C.) pervigilans.

152. Chatham Island, road just S of Owenga, 26 Feb 64, S. Stream margin; slow current; muddy water; abundant grassy vegetation; mud bottom; full sun. Culex (C.) pervigilans.

153. Chatham Island, Waitangi West, 28 Feb 64, S. Large ground pool; clear fresh water; scanty algae; mud and sand bottom; full sun. *Culex (C.) pervigilans*.

154. Chatham Island, Waitangi, 29 Feb 64, S. Clear rainwater in dinghy; partial shade. *Culex (C.) pervigilans*.

155. Chatham Island, Te Awarakau near Waitangi, elev. 4 m, same locality as collection 150, 2 Mar 64, S. Large seaside rockpools and seepages; slow current; water fresh to salty; scanty flotage and algae; sand and rock bottom with decaying vegetation; full sun. *Aedes (N.) chathamicus*.

156. Springs Junction, Springsland Creek behind Rahu Post Office (Nelson), elev. 1820 ft, 9 Mar 64, S. Stream margins; moderate current; clear, fresh water; scanty grassy vegetation; gravel bottom; full sun. *Paradixa fuscinervis*.

157. Tahunanui, stream E of Motor Camp (Nelson), elev. 3 m, 10 Mar 64, S. Stream margin; moderate current; fresh water, muddy due to flooding; abundant grassy vegetation; mud bottom; partial shade. *Culex (C.) pervigilans*; *Aedes (O.) antipodeus*.

158. Annesbrook (Nelson), elev. ca 20 m, 10 Mar 64, S. Stream margin; moderate current; clear water; scanty grassy vegetation; gravel bottom; partial to full sun. *Paradixa neozelandica*; *P. fuscinervis*.

159. Ngawhatu Mental Hospital, streams along road (Nelson), 11 Mar 64, S. Stream margins; moderate current; clear, fresh water; grassy vegetation; partial shade. *Paradixa fuscinervis*.

160. Stoke, Polstead Road (Nelson), 11 Mar 64, S. Swamp margin; stagnant, clear, fresh water; abundant grassy vegetation. *Culex (C.) pervigilans*.

161. Brightwater, main highway bridge over Waimea River (Nelson), 11 Mar 64, S. River margin; moderate current; turbid fresh water; scanty grassy vegetation; mud, sand and gravel bottom; partial shade. *Paradixa fuscinervis*.

162. Nelson, Reservoir (Nelson), 12 Mar 64, S. Stream margin; slow current; clear, fresh water; scanty vegetation; mud, sand, gravel and rock bottom; deep shade. *Paradixa neozelandica*; *P. fuscinervis*.

163. Nelson, Reservoir (Nelson), 12 Mar 64, S. Tire with mud and decaying vegetation on bottom; partial shade. *Culex (C.) pervigilans*.

164. Blick's Valley, stream off Brook Stream (Nelson), 12 Mar 64, S. Stream margin; slow to moderate current; clear fresh water; grassy vegetation; partial to full sun. *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

165. Dodson's Valley Stream (Nelson), elev. ca 68 m, 12 Mar 64, S. Stream margin; slow to moderate current; clear fresh water; abundant grassy vegetation; mud and gravel bottom; partial shade. *Nothodixa campbelli*; *Paradixa neozelandica*; *P. fuscinervis*.

166. Todd's Valley Stream (Nelson), 12 Mar 64, S. Stream margin; slow to moderate current; clear fresh water; grassy vegetation; mud and gravel bottom. *Paradixa neozelandica*; *P. fuscinervis*.

167. Wakapuaka, Glen Road (Nelson), 12 Mar 64, S. Ditch under road; slow current; clear fresh water; grassy vegetation; mud bottom; partial shade. *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

168. The Glen (Nelson), 12 Mar 64, S. Stream margin just before beach; slow current; clear fresh water; grassy vegetation; gravel and rock bottom. *Nothodixa campbelli*; *Paradixa neozelandica*; *P. fuscinervis*.

169. Howard Junction, 1 mi E, along Buller River (Nelson), 13 Mar 64, S.

Large ground pool adjacent to river; clear fresh water; abundant grassy vegetation and duckweed; partial shade. Paradixa neozelandica; P. fuscinervis; P. tonnoiri; Culex (C.) pervigilans.

170. Nelson, Maitai River, near Pole Ford Bridge (Nelson), 14 Mar 64, S. Ditch along road; slow current; clear fresh water; mud bottom; partial shade. Paradixa neozelandica; P. fuscinervis; Culex (C.) pervigilans.

171. Nelson, Maitai River and Dod's Creek at Smith's Ford (Nelson), 14 Mar 64, S. Stream margin; slow current; clear fresh water; mud and gravel bottom; partial shade. Paradixa neozelandica; P. fuscinervis.

172. Rakino Island (Hauraki Gulf), 25 Jan 64, F. Seaside rockpool above high tide; chloride 34000 ppm. Opifex fuscus.

173. Rakino Island (Hauraki Gulf), 24 Jan 64, F. Seaside rockpool above oyster zone; chloride 34000 ppm. Opifex fuscus.

174. Ohakune, pond on bend of Lake Road, south of Rangataua Reserve, Lake (Wellington), 26 Jan 64, F. Same locality as collection 85. Culex (C.) pervigilans.

175. Ohakune, Mt. Road, first stream below first bridge (Wellington), 26 Jan 64, F. Same locality as collection 83. Paradixa fuscinervis.

176. Ohakune, pond on bend of Lake Road, south of Rangataua Reserve Lake (Wellington), 28 Jan 64, F. Same locality as collections 85 and 174. Culex (C.) pervigilans.

177. Waitakere Ranges, Cascade Park, Waitakere stream (North Auckland), 20 Feb 64, F. Sweeping and netting. Paradixa fuscinervis; Coquillettidia (C.) iracunda.

178. Waitakere Ranges, Cascade Park, Waitakere stream, bridge below Cascade Falls (North Auckland), 20 Feb 64, F. Paradixa fuscinervis.

179. Waitakere Ranges, Bethells Road near Quarry (North Auckland), 11 Apr 64, F(D1). Stream margins and pools; slow current; clear fresh water; no vegetation; rock and mud bottom; partial shade. Paradixa fuscinervis; P. harrisi.

180. Mangere Sewage Plant (North Auckland), 22 Apr 64, F(D3). No. 1 oxidation pond; water green with algae; mud bottom; full sun. Culex (C.) quinquefasciatus.

181. Henderson, Opunaku Stream (North Auckland), elev. 65 m, 26 Apr 64, F(D4). Stream pool; slow current; clear fresh water; some Potamageton; mud and rock bottom; partial shade. Paradixa fuscinervis.

182. Albany, Rosedale Road (North Auckland), elev. 100 m, 18 May 64, F (D5). Stream pool; slow current; clear fresh water; mud and rock bottom with decaying vegetation; deep shade. Paradixa neozelandica; P. fuscinervis.

183. Swanson, Train Valley Stream (North Auckland), elev. 166 m, 9 May 64, F(D6). Stream pool; slow current; turbid yellowish water; partial shade. Paradixa fuscinervis.

184. Waitakere Ranges, Bethells Road Swamp (North Auckland), 9 May 64, F(D7). Swamp margin; yellowish-brown fresh water; abundant vegetation of Typha and reeds; mud bottom with decaying vegetation; partial shade; 2 in rain in previous 5 days. Culex (C.) pervigilans.

185. Rotorua, Whakarewarewa (South Auckland), 19 May 64, F(D8). Margins of stream bounding thermal area; temperature of water normal not thermal; slow current; turbid water with slight sulfurous odor; scanty vegetation; sand bottom; partial shade. Culex (C.) rotoruae.

186. Pukehoke, Sewage Oxidation Pond (North Auckland), elev. 60 m, 25 May 64, F(D9). Oxidation pond; clear fresh temporary water; scanty grassy

and herbaceous vegetation; mud bottom; full sun. Culex (C.) pervigilans.

187A. Ocean Beach, Whangarei Heads (North Auckland), 31 May 64, F(D10). Landing and resting collection of adults at rockpool; 1445 hrs; clear, sunny. Opifex fuscus.

187B. Ocean Beach, Whangarei Heads (North Auckland), 31 May 64, F(D10). Seaside volcanic rockholes at 9 ft above high tide level; clear water; sand bottom; full sun. Opifex fuscus.

188. Wellsford, stream under route 1 north of town (North Auckland), elev. 100 m, 31 May 64, F(D11). Stream margin; slow current; clear fresh water; sparse growth of Typha; mud bottom; partial shade. Paradixa fuscinervis; Culex (C.) pervigilans.

189A. Titirangi, French Bay (North Auckland), elev. 50 m, 14 June 64, F (D12). Dixids flying over breeding site 189B; 1200 hrs; showery and humid. None collected.

189B. Titirangi, French Bay (North Auckland), elev. 50 m, 14 June 64, F (D12). Stream pool; slow current; turbid fresh water; scum; mud bottom; deep shade. Paradixa fuscinervis; P. harrisi.

190. Tuakau, bridge over Waikato River (North Auckland), elev. ca 10 m, 9 June 64, F(D13). Ditch into Waikato River; slow current; clear fresh water; no vegetation; mud bottom; partial shade. Paradixa fuscinervis; Culex (C.) pervigilans.

191A. Titirangi Beach, Mahoe Road (North Auckland), elev. 6 m, 4 July 64, F(D14). Landing on collector; 1100 hrs. Aedes (F.) notoscriptus.

191B. Titirangi Beach, Mahoe Road (North Auckland), elev. 6 m, 4 July 64, F(D14). Small tin can with clear water; oil on surface; mud bottom; deep shade. Aedes (F.) notoscriptus; Maorigoeldia argyropus.

192A. Titirangi, French Bay (North Auckland), elev. 5 m, 4 July 64, F(D15). Adults swarming over ditch, about 1 m; 1100 hrs. Paradixa neozelandica; P. fuscinervis.

192B. Titirangi, French Bay (North Auckland), elev. 5 m, 4 July 64, F(D15). Ditch; slow current; turbid fresh water; flotage; mud bottom with decaying vegetation; deep shade. Paradixa neozelandica; P. fuscinervis.

193. Titirangi Beach, Mahoe Road (North Auckland), elev. 2 m, 4 July 64, F(D16). Stream margin; slow current; turbid fresh water; no vegetation; mud bottom; partial shade. Paradixa fuscinervis.

194. Avondale, Auckland, Methuen Road (North Auckland), elev. 60 m, 9 Aug 64, F(D15!). Washing machine bowl in domestic yard; yellowish water with decomposing leaves; deep shade. Culex (C.) quinquefasciatus; Aedes (F.) notoscriptus.

195A. Waitakere Ranges, on Bethells Road ca 10 yd from Black bridge and bridge on Cascade turnoff (North Auckland), elev. 20 m, 15 Nov 64, F(D17). Sweeping collection.

195B. Waitakere Ranges, on Bethells Road ca 10 yd from Black bridge and bridge on Cascade turnoff (North Auckland), elev. 20 m, 15 Nov 64, F(D17). Ground pool; yellowish, fresh water; mud bottom with decaying vegetation; partial shade. Paradixa neozelandica; P. fuscinervis.

195C. Titirangi Beach, Mahoe Road (North Auckland), elev. 5 m, 29 Nov 64, F. Coquillettidia (C.) iracunda.

196. Martins Bay, Mahurangi Heads (North Auckland), elev. 3 m, 26 Dec 64, F(D21). Marshy depression in swamp; turbid fresh water; abundant watercress; mud bottom; full sun. Paradixa neozelandica; Culex (C.) pervigilans.

197. Martins Bay, Mahurangi Heads (North Auckland), 29 Dec 64, F(D23).

Blocked ditch on beach; clear fresh water; abundant scum and sedges; mud bottom with decaying vegetation; partial shade. *Paradixa neozelandica*.

198A. Mangawhai Heads, Waipu Road (North Auckland), elev. 12 m, 2 Jan 65 F(D26). Stream margin; slow current; clear fresh water; flotage present, no vegetation; gravel bottom; partial shade. *Paradixa fuscinervis*.

198B. Dome Valley (North Auckland), 2 Jan 65, F. *Paradixa neozelandica*; *P. fuscinervis*.

199. Piriaka, 6 mi S of Taumarunui (Wellington), elev. 200 m, 5 Jan 65, F(D28). Stream pool in tributary of Wanganui River, 4 x 8 ft, 10 in deep; slow current; clear fresh water; flotage of willow leaves; mud bottom with willow roots; partial shade. *Paradixa neozelandica*; *P. fuscinervis*.

200A. Waitakere Ranges, Bethells Road Swamp (North Auckland), 10 Jan 65, F(D29). Biting and sweeping collection, 1630 hrs. *Coquillettidia (C.) iracunda*; *Aedes (F.) notoscriptus*.

200B. Waitakere Ranges, Bethells Road Swamp (North Auckland), 10 Jan 65, F(D30). Swamp margin; reddish brown fresh water; abundant *Typha* and reeds; deep shade. *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*; *Coquillettidia (A.) tenuipalpis*; *C. (C.) iracunda*.

201. Mangere (North Auckland), 7 Jan 65, F(D31). *Culex (C.) pervigilans*.

202. Waitakere Ranges, Bethells Road Swamp (North Auckland), 12 Jan 65, F(D32). Same locality and data as collection 200B. *Paradixa neozelandica*; *P. fuscinervis*; *Culex (C.) pervigilans*.

203A. Dome Valley, southern end, near Warkworth (North Auckland), 16 Feb 65, F(D32). Sweeping under bridge; 1000 hrs. Dixids.

203B. Dome Valley, southern end, near Warkworth (North Auckland), 16 Feb 65, F(D32). Stream margin; slow current; turbid, reddish fresh water; grassy vegetation; mud bottom; deep shade. *Culex (C.) pervigilans*.

204A. Wellsford, first bridge S of city on highway 1 (North Auckland), 16 Feb 65, F(D33). Stream pool; clear fresh water; abundant grassy and herbaceous vegetation; mud bottom with decaying vegetation; deep shade. *Paradixa fuscinervis*.

204B. Kaitaia, Kaitaia Hotel (North Auckland), 16 Feb 65, F. On wall in hotel. *Coquillettidia (C.) iracunda*.

205. Mangamuka Gorge, E side of highway 1, dammed section of stream marked "Fresh Water" (North Auckland), elev. ca 500 m, 18 Feb 65, F(D35). Stream margin and pool; slow current; clear fresh water; submerged vegetation, *Callitriche*, *Nitella*; mud bottom; deep shade. *Nothodixa campbelli*; *Paradixa harrisi*.

206. Mangamuka Gorge, S slope, at bridge (North Auckland), 18 Feb 65, F(D36 and D36A). Stream pool; slow current; clear fresh water; scanty vegetation; mud bottom; deep shade. *Paradixa fuscinervis*; *P. harrisi*.

207. Brynderwyn Roadside, S slope (North Auckland), elev. ca 300 m, 18 Feb 65, F(D37). Stream pool at foot of waterfall; slow current; clear fresh water; scanty flotage and vegetation, *Callitriche*; mud and gravel bottom; partial shade. *Paradixa harrisi*.

208. Dome Valley, bridge S of Wellsford (North Auckland), 18 Feb 65, F (D38). Stream margin and pool; slow current; turbid fresh water; some flotage; mud bottom with decaying vegetable debris; deep shade. *Paradixa fuscinervis*.

209A. Mangere Sewage Treatment Plant (North Auckland), 9 Mar 65, F(D40). Adults swept from grassy margin of pond. *Paradixa neozelandica*.

209B. Mangere Sewage Treatment Plant (North Auckland), 9 Mar 65, F(D40).

Pond; turbid, yellowish fresh water; abundant algae and grassy vegetation; mud bottom; full sun. Paradixa neozelandica.

209C. Mangere Sewage Treatment Plant (North Auckland), laboratory colony established from collection 209B, 9 Mar 65, F(D40, D42). Paradixa neozelandica.

210. Piriaka, S of Taumarunui (Wellington), elev. 200 m, 28 Mar 65, F (D43). Stream margin; slow current; clear fresh water; abundant grassy vegetation; mud bottom with decaying vegetation; partial shade. Paradixa neozelandica; P. fuscinervis.

211. Te Aroha, 10 mi S, ca 0.5 mi from waterfall on dead end road (South Auckland), 5 June 65, F(D45). Stream margin; slow current; clear fresh water; abundant flotage and grassy vegetation; mud and sand bottom with decaying vegetation; partial shade. Paradixa neozelandica; P. fuscinervis; P. harrisi.

212A. Ohakune, Rangataua Reserve Lake (Wellington), elev. 600 m, 6 June 65, F(D46). Sweeping along margin of lake; 1620 hrs. Paradixa neozelandica.

212B. Ohakune, Rangataua Reserve Lake (Wellington), elev. 600 m, 6 June 65, F(D46). Lake margin; clear fresh water; abundant vegetation; mud bottom with decaying vegetation; partial shade. Paradixa neozelandica.

213. Between Piriaka and Taumarunui, on highway 4 at Manunui turnoff (Wellington), 7 June 65, F(D47). Ditch; slow current; turbid, brownish fresh water; abundant pasture grass; mud bottom with decaying vegetation; partial shade. Paradixa neozelandica; P. fuscinervis.

214. Mapiu, picnic area ca 5 mi S on highway 4 (South Auckland), 7 June 65, F(D48). Ditch; moderate current; clear fresh water; abundant vegetation; mud bottom with decaying vegetation; partial shade. Paradixa fuscinervis.

215. Mangere Purification Plant, experimental pond A (North Auckland), 15 June 65, F(D49). Pond; turbid, yellowish fresh water; abundant flotage, algae and grassy vegetation; mud bottom with decaying pasture grass; full sun. Paradixa neozelandica.

216A. Mangere Purification Plant, experimental pond B (North Auckland), 15 June 65, F(D50). Pond; turbid, yellowish fresh water; abundant flotage, algae and pasture grass; mud bottom with decaying vegetation; full sun. Paradixa neozelandica.

216B. Avondale (North Auckland), elev. 60 m, 23 Nov 64-11 Jan 65, F. Paradixa neozelandica; P. fuscinervis; Culex (C.) pervigilans.

217. Blackhead, Dunedin (Otago), 23 Feb 64, N. Stream margin about 100 yd from shore; very slow current; watercress. Paradixa neozelandica.

218. Coromandel (South Auckland), 21 Apr 64, N. Boat hull. Culex (C.) quinquefasciatus.

219. Coromandel (South Auckland), 22 Apr 64, N. Astelia axils. Culex (C.) asteliae.

220. Coromandel (South Auckland), 25 Apr 64, N. Weedy ditch. Culex (C.) pervigilans.

221. Coromandel (South Auckland), 25 Apr 64, N. Overgrown mine workings. Paradixa neozelandica.

222. Coromandel (South Auckland), 26 Apr 64, N. Domestic water tank. Aedes (F.) notoscriptus.

223. Hooper's Inlet, Dunedin (Otago), 3 Aug 63, N. Ditch. Aedes (O.) subalbirostris.

224. Bridge Flat-Haast Road, NZ S1 (Westland), 18 Dec 66, N. Slow-flowing water on forest edge. Paradixa fuscinervis; P. tonnoiri.

225. Waitakere Ranges, Bethells Road Swamp (North Auckland), 6 Dec 66, D. Coquillettidia (A.) tenuipalpis.

APPENDIX B

Laboratory Colonization of Paradixa neozelandica Tonnoir

By

Don Forsyth[1]

Colonies of the dixa midge Paradixa neozelandica (Tonnoir, 1924) can be readily established and maintained in the laboratory for indefinite periods under quite simple conditions.

Due to the wide degree of individual variation in features of the wing venation and male genitalia observed in adults of this species collected throughout the Auckland province, New Zealand, colonization under artificial conditions was valuable as a means of determining the range of variation and establishing whether or not a character bred true.

The breeding unit comprised a clear plastic tank 16 inches by 10 inches by 8 inches deep, on the floor of which was placed a "Hykro" underground filter, type P 70, size 2. The vertical air outlet pipe of this was cut down to 5 inches and the offcut cemented to the basal piece at a right angle and parallel to the short sides of the tank. The water level was taken to 1/2 inch above this horizontal limb and the inlet air pipe connected to an aerator. The entry of air was adjusted to give a moderate flow of water at a rate of 2 feet per second which was deflected from the opposite wall to circulate around the tank thus simulating conditions encountered in the field. It was found necessary to place some weights upon the filter to prevent it from floating and to keep it in a fixed position on the floor of the tank since no substrate material was used as this would defeat the purpose of the filter, i.e. that of keeping the solid organic particles in the water in suspension and circulation (the orthodox use of an underground filter being to remove such materials from suspension and to maintain the water in a clear and well-aerated condition).

Three feeding methods were used to maintain the culture:

1) Water from the larval collecting site along with a small amount of substrate to provide natural nutrients.

2) Tap water into which soya bean flour was introduced daily, rapidly producing a flourishing growth of assorted unicellular algae and protozoans.

3) Tap water with the addition of a pure culture of the unicellular green alga, Euglena sp.

Of these, the second method proved to be most effective in that it was simply maintained and produced the shortest life cycle, 20 days from egg to adult. However, in some areas the local tap water may not be entirely suitable owing to the method of pre-treatment and in such cases methods (1) and (2) could be combined.

The colony was established from 24 fourth-instar larvae collected in the field and introduced into the tank which was covered by fine muslin. The larvae pupated and adults subsequently emerged, some of the females producing

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fertile eggs. The latter were enclosed in a circular, clear, gelatinous matrix (25 to 78 eggs per mass) and were white at first and later became dark brown as development proceeded. The egg masses were deposited on the tank walls at the meniscus directly opposite the water outlet where the flow was greatest, regardless of light intensity or direction.

Each female laid a single clutch of eggs which hatched with an average period of time of 4 days. The young first instar larvae remained within the gelatinous matrix for up to 24 hours before swimming freely when they were swept away to less turbulent parts of the tank where they pushed themselves upwards on the tank walls out of the meniscus to assume their characteristic inverted U-shaped attitude within a thin film of water.

Even as later generations became out of phase and overlapped and larval density rose, the second, third and fourth-instar larvae continued to inhabit the less turbulent areas so that the newly hatched larvae while still within the egg mass were not subjected to their interference.

For the 3 methods used the life cycle averaged 30 days at 20°C. Adult life averaged 4 days during which time no food was apparently taken. The females oviposited within 72 hours of emergence.

The colony was maintained continuously for 5 generations (before being discarded) without larval mortality although 30 percent of the egg masses produced did not hatch, probably because they were not fertilized.

This is the first record of the laboratory colonization of a dixa midge and it is to be hoped that the method can be adopted by future workers for other members of the group.

INDEX TO SCIENTIFIC NAMES